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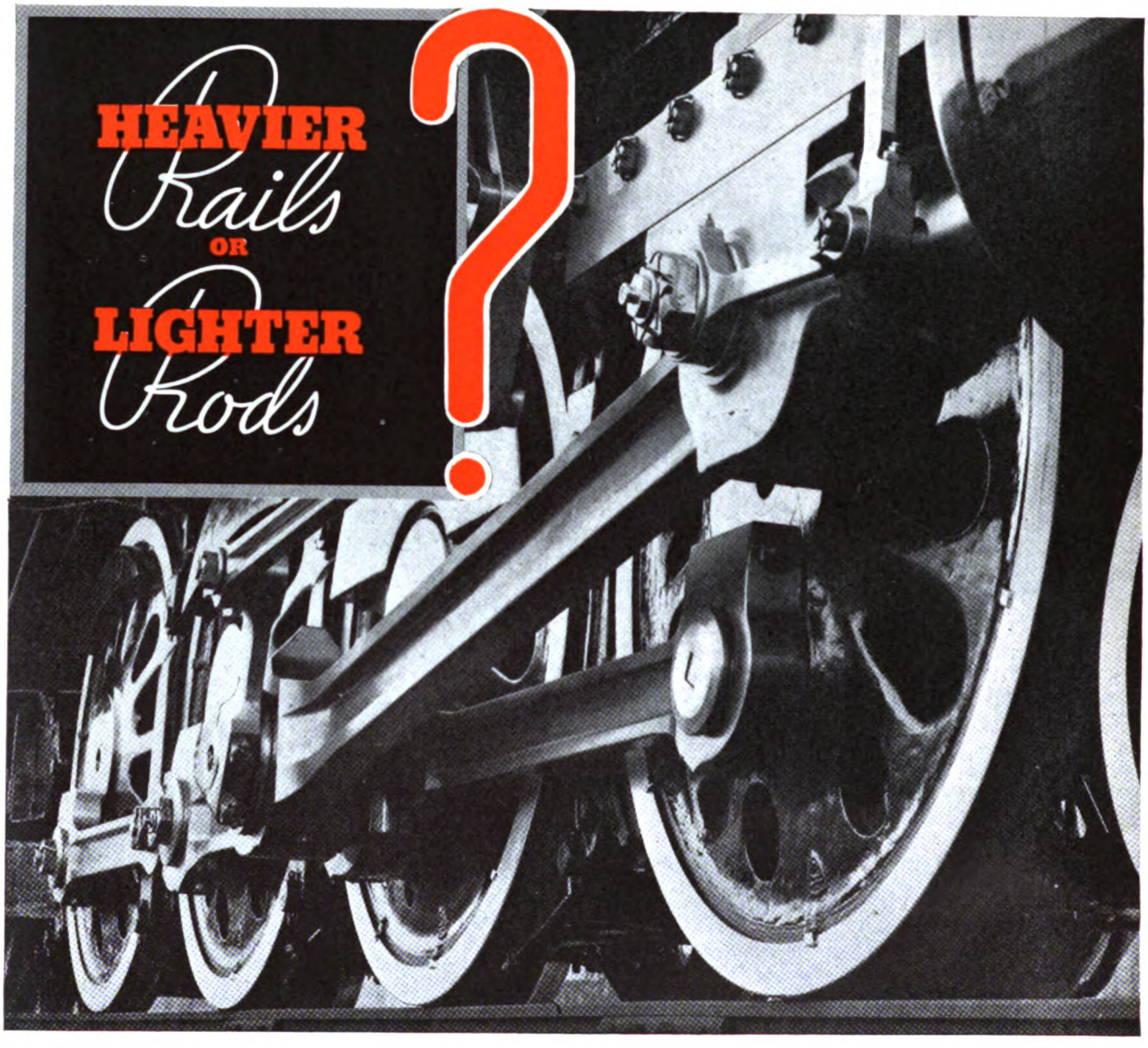
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RAILWAY
MECHANICAL ENGINEER



Reading Installs

A Light Streamline Train

Five cars of Budd stainless-steel construction running on fast schedule between Philadelphia and New York — The train is symmetrical about the diner in the center—Hauled by a streamline Pacific type locomotive

ON December 13 the Reading Company placed in service on the Reading-Jersey-Central line between New York and Philadelphia, Pa., a lightweight streamline stainless-steel train of five cars built by the Edward G. Budd Manufacturing Co. The train is drawn by a Pacific type steam locomotive remodelled and streamlined at the Reading shops of the railroad. The lines of the locomotive conform with the sheathing of the cars, thereby presenting a continuity of line and surface throughout the train.

The train is made up of four chair cars and one tavern-dining car. The two end chair cars are constructed as observation cars to obviate the necessity of turning the entire train around after its arrival at either terminal. The end cars each contain 56 coach seats and 14 individual lounge chairs and the other chair cars each have 56 coach seats and 12 individual lounge chairs. The dining car accommodates 24 passengers at tables in the dining room and 27 passengers in the tavern or cocktail lounge.

The Car Structures

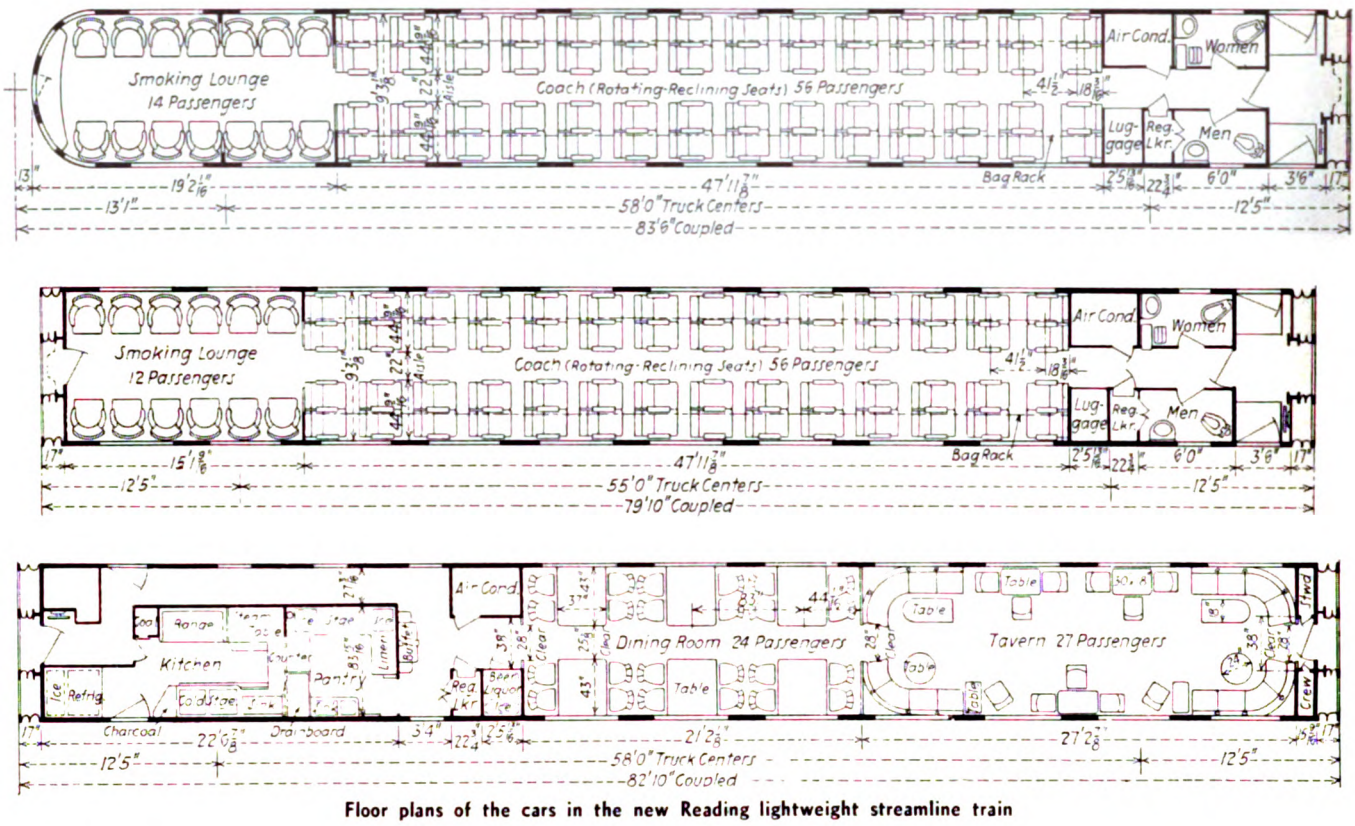
All car sheathing and structure, except the end underframes, are the well-known 18-8 stainless steel. This is used in two strengths. The high-tensile material has a tensile strength of 150,000 lb. per sq. in. and is used where light weight and strength are of prime importance, and the low-tensile material has a tensile strength of 100,000 lb. per sq. in. and is used where workability or special finishes is required. The Budd Shotweld process was used in the fabrication of these cars.

Fundamentally, the structure of the cars is a modified girder wherein the roof and under structure serve as compression and tension chords, and the two modified Pratt-truss side frames are the webs. The end structure is designed to withstand buffing, traction, vertical and lateral loads that are to be expected in service and as required by Railway Mail Service. The end underframes are made of Cromansil steel, arc welded into a unit, subsequently stress relieved and riveted to reinforced body members.

Doors are of all-metal construction, with a light of ¼-in. shatterproof glass in the upper portion. The stainless steel used in the outside doors is in harmony with the exterior metal. The passenger steps are so constructed that they are raised into the car body when the vestibule trap doors are closed, presenting a smooth exterior appearance.

All passenger side windows are double-glazed, with ¼ in. polished plate glass in the outer frame and ¼-in. shatterproof plate glass in the inner frame, with about ¼ in. air space between them. The outer window frames are attached directly to the car body, while the inner sash is hinged at the top to facilitate cleaning. The window frames are of all-metal construction and the glass is held in place by molded rubber strips. The toilet-room windows are single-glazed, with shatterproof flashed opal glass.

The cars are thoroughly insulated. The side walls, floors, roofs and ends are insulated with Stonefelt and the windows are of double-glazed construction to further reduce heat losses. The side, end and roof insulation



Floor plans of the cars in the new Reading lightweight streamline train

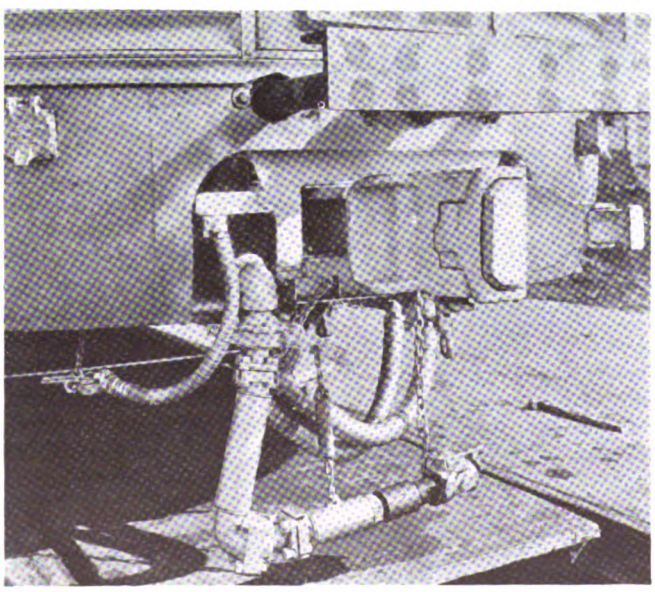
is held in place by metal clips and bands. The sub-floor insulation is supported by flat sheets of stainless steel on the under side.

Air Conditioning and Lighting

The Airtemp electro-mechanical air-conditioning equipment comprises a compressor-condenser unit of about 6½ tons' capacity mounted beneath each car floor, and an evaporator unit placed in a locker in each car body. A controllable amount of filtered fresh air is taken through louvered openings in the car roof, mixed with air drawn from the passenger compartment and forced through the conditioning unit and into the distributing duct which is made of galvanized steel insulated with ½-in. Deadnox. This duct, which is placed above the ceiling between the light ducts, allows the air to escape through a concealed narrow slot in the lower edge of each side. Incorporated in the evaporator is a steam heater coil of about 80,000 B.t.u. capacity for use when heated air is required. Finned copper-tube steam radiators are placed at the base of the walls for general car-heating purposes. The Vapor heating system is employed, with Barco steam-heat connections between the cars.



Details of the underframe and side construction



One of the controlled slack couplers

This train is the first complete installation of the Vapor correlative control of both heating and cooling. With this control system the only manual operation required is in changing over from cooling to heating or vice versa. In cooling the differential between the inside and outside temperatures is effected automatically under the control of an adjuster thermostat located in the fresh-air intake. With an outside temperature of



A side frame in process of fabrication

100 deg. or higher the inside temperature of the car is under control of an 80-deg. maximum thermostat. For each 3-deg. drop in outside temperature below 100 deg. F. a drop of 1 deg. is automatically effected in the temperature inside the car until the inside temperature has dropped to 72 deg. Should the outside temperature drop below 72 deg. with the control set for cooling, the adjuster thermostat is automatically dropped out of the circuit, thus preventing any further lowering of the inside temperature under outside temperature control. Both the overhead and floor heat are tied in the same automatic circuit controlled by an adjuster thermostat, in this case located in the recirculating air duct. This is set for a 3-deg. differential between the overhead and floor heat.

A separate ventilation system is installed in the kitchen. Fresh filtered air is delivered directly to the kitchen without passing over evaporator coils and is moved by exhaust ventilators, the capacity of which slightly exceeds that of the intake blowers. One intake blower feeds two ducts which extend along the sides of the doorway between the kitchen and dining room. These ducts deliver a curtain of air across the doorway, which is drawn into the kitchen by the action of the exhaust fans, thereby preventing the escape of kitchen odors.

The electrical system operates at 32 volts d.c. The current is supplied by Exide 1,000-amp. hr. batteries and the Safety Car Heating & Lighting Co. 20-kw. generators. The batteries are carried in a stainless-steel battery box mounted beneath the car. The generator is mounted longitudinally under the car and connected to an axle by the D.R. drive—a combination of vee belts, bevel gears and longitudinal drive shaft.

Provision is made for the operation of the air-conditioning equipment from a standby source of power. The motors are built for operation on both 32-volt d.c. and 220-volt a.c. The cars are equipped with both d.c. and three-phase a.c. receptacles for receiving standby power.

Direct and indirect concealed lighting is used in various parts of the cars. The indirect lights are concealed in two ducts recessed in the ceiling. The ducts are painted white and reflect light onto the car ceiling to create an almost shadowless illumination in the car. Direct lighting supplements the indirect system in the lounges, dining room and tavern. The cove over the windows is constructed behind the side ceiling lining and is glazed on the under side in a horizontal plane, the light from this source offering comfortable reading conditions to passengers in the sections so equipped. Bag-rack fixtures in the coaches are centered over each seat and concentrate their light downward.

Weights of Cars in Reading Lightweight Streamline Train

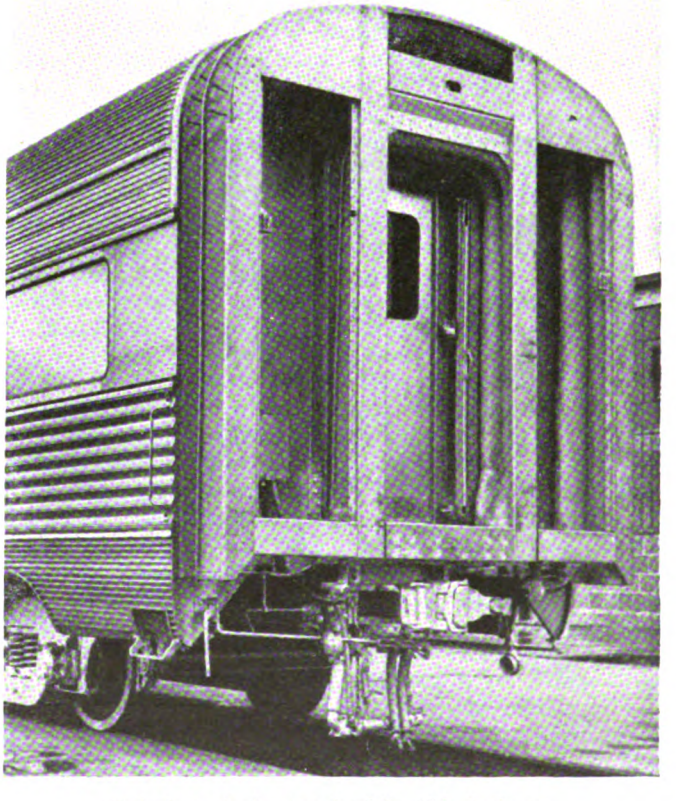
Car No.	Weight, lb.
1	98,914
2	95,774
3	110,399
4	96,024
5	98,914
Total	500,025

The vestibules, aisles and toilets are lighted from overhead fixtures recessed into the ceilings of these sections.

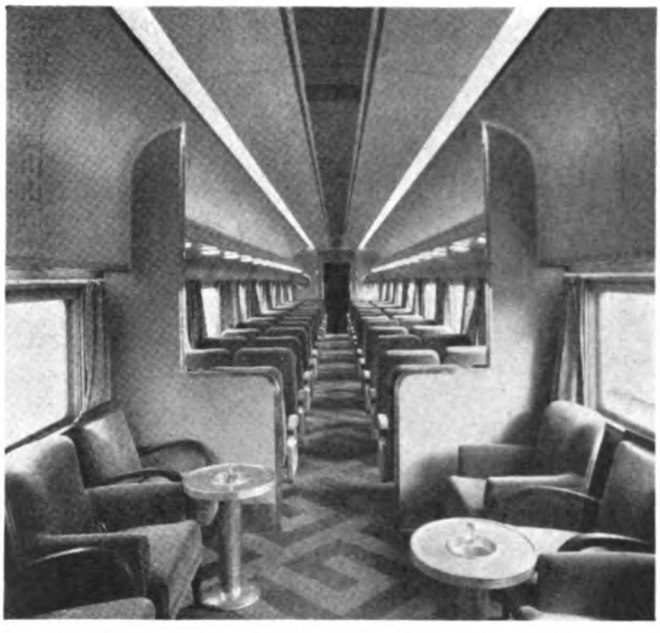
The power brake is the Westinghouse Air Brake Company's electro-pneumatic modified H.S.C., operated by air pressure supplied by the locomotive and controlled electrically. There is a belt-driven speed governor on each of two trucks on the train which controls braking pressures at various speeds. The hand brakes are of the wheel type mounted on a lightweight housing.

The Trucks

The cars are carried on four-wheel trucks of the conventional equalized swing bolster type. The wheel base measures 9 ft. Each truck is fitted with four Houde



End of coach showing the full-width diaphragm



Looking from the lounge section in one of the coaches

hydraulic shock absorbers to dampen the lateral swing action. Vibration and sound deadening is controlled by the use of insulation at strategic points. All castings are alloy steel, heat treated, and the equalizers are forged steel, machined all over. The axles are fitted with 36-in. multi-wear wheels and Fafnir combined ball- and roller-bearing journal boxes. The radial load is carried on hardened solid rolls, while the lateral thrusts are resisted by high-capacity ball bearings. The bearing housing is of alloy steel, hardened, and is reversible for double wear. The trucks are fitted with the Simplex Unit Cylinder clasp brakes.

Interior Treatment

The end cars are identical in layout and structure, but differ in color treatment. In one of the cars the main features of the color scheme are olive brown walls and coral upholstery; in the other they are aquamarine and chamois. Similarly, the second and fourth cars are alike in arrangement, but one is decorated with clay color on the side walls and green upholstery, and the other with olive-green walls and brown frieze upholstery. In addition to the roller shades, drapes are placed at the sides of the windows in all of the cars.

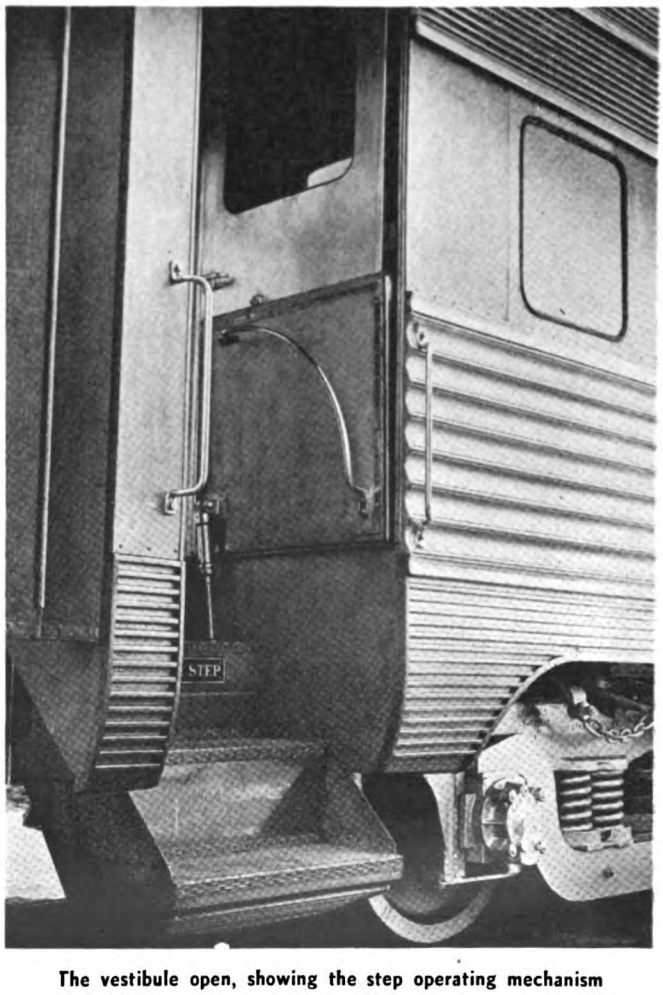
The floor plans indicate that each of four cars has a smoking lounge. Those at the ends of the train each seat 14 passengers in individual chairs and each is fitted with a table in the rounded end of the lounge, with shelves at the sides. The lounge in each of the other two coaches seats 12 passengers in individual chairs. The passenger compartments in each of these four cars is fitted with the rotating type, two-passenger seats, with individual reclining backs and sliding cushions. The cushions are molded sponge rubber and the backs are of spring construction. The individual arm chairs in the lounges are of wood-frame construction with molded sponge-rubber cushions and spring backs. The flooring in all four coaches is Linotile in a checkerboard pattern, the colors varying from car to car. Each car has a man's and a woman's toilet adjoining the vestibule.

The middle car in the train is a 24-passenger dining room, with a tavern compartment seating 27 persons at wall seats and individual chairs at small tables, and a kitchen and pantry. The kitchen equipment comprises a refrigerator at the extreme end of the kitchen; a coal range and water boiler; a broiler; two coal bins, one with a crew's locker above it; a steam table; a coffee urn, which stands on the steam table but with the faucet projecting into the pantry; two sinks with swivel faucets, one in the kitchen and one in the pantry; a service shelf; a low kitchen refrigerator; a fruit chill box; a liquor refrigerator and liquor locker, and numerous small lockers and compartments for the storage of dishes and supplies. All equipment in the kitchen is made of stainless steel, with the exception of the coal-burning range, and all exposed side wall is covered with sheet stainless steel. The miscellaneous hardware is chromium plated.

The dining room and tavern are decorated in olive-brown with touches of red and the upholstering is tan leather with red piping. The floor covering in both rooms is Seamloc carpet in raisin and henna. A Velvetex pad is placed under the carpet.

The Locomotives

The locomotives, two of which have been streamlined for use with this train, are the road's Class GISA Pacific type, some of which were originally built by the railroad



The vestibule open, showing the step operating mechanism

at its Reading shops. The two locomotives in question are from this group. They develop a tractive force of 40,900 lb., with a boiler pressure of 220 lb., cylinders 25 in. in diameter by 28 in. stroke, and driving wheels 80 in. in diameter. The boiler has a total evaporative heating surface of 2,984 sq. ft. The superheating surface is 621 sq. ft. and, originally built for anthracite service, the firebox has a grate area of 94.5 sq. ft.

The locomotive and tender have been shrouded and

(*Continued on page 18*)

A Study, Based on Laboratory Results, of

The Locomotive Front End

Part I

By H. S. Vincent*

An investigation of the laws which govern the flow of steam and gas in a locomotive front end—The author discusses the feasibility of reducing back pressure in locomotive cylinders

THE comprehensive tests of a front-end model,[1] recently made by E. G. Young and his associates, has served to focus attention upon a part of the steam locomotive which has been the subject of more or less empirical treatment since the days of Stephenson. The forces operating in the locomotive front end and the method of controlling them are better understood through the model experiments of Young as well as through the work of earlier investigators. Applying the laws of similarity, there is every reason to assume that the principles involved in the experiments with the model apply with equal force to the actual locomotive.

For the past thirty years, practically every coal-burning locomotive has been equipped with a modification of the Master Mechanics front-end arrangement, adopted in 1906 by the American Railway Master Mechanics Association and described in its proceedings for that year. In a recent report to the Mechanical Division of the Association of American Railroads,[2] presented by its Committee on Locomotive Construction, the continued use of the Master Mechanics type of locomotive front end is recommended and rules are promulgated for the area of the various gas passages, based on maintaining a definite proportion of the area through tubes and flues.

In this discussion, it is the author's purpose to attempt an investigation of the laws which govern the flow of steam and gas in a locomotive front end and to determine the feasibility of reducing back pressure in the locomotive cylinders. In making this study, data from the most recent laboratory tests of locomotives have been used and in addition some of the earlier data have been employed. In Table I, the principal character-

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[1] "A Study of The Locomotive Front End, Including Tests of A Front-End Model," by E. G. Young, Bulletin 256 of the Engineering Experiment Station, University of Illinois, Urbana, Ill., May 30, 1933. Also, "A Supplementary Study of the Locomotive Front End by Means of Tests on A Front-End Model," by E. G. Young, Bulletin 274 of the Engineering Experiment Station, University of Illinois, Urbana, Ill., May 21, 1935.

[2] Abstracted in the August, 1936, issue of the *Railway Mechanical Engineer*, page 339.

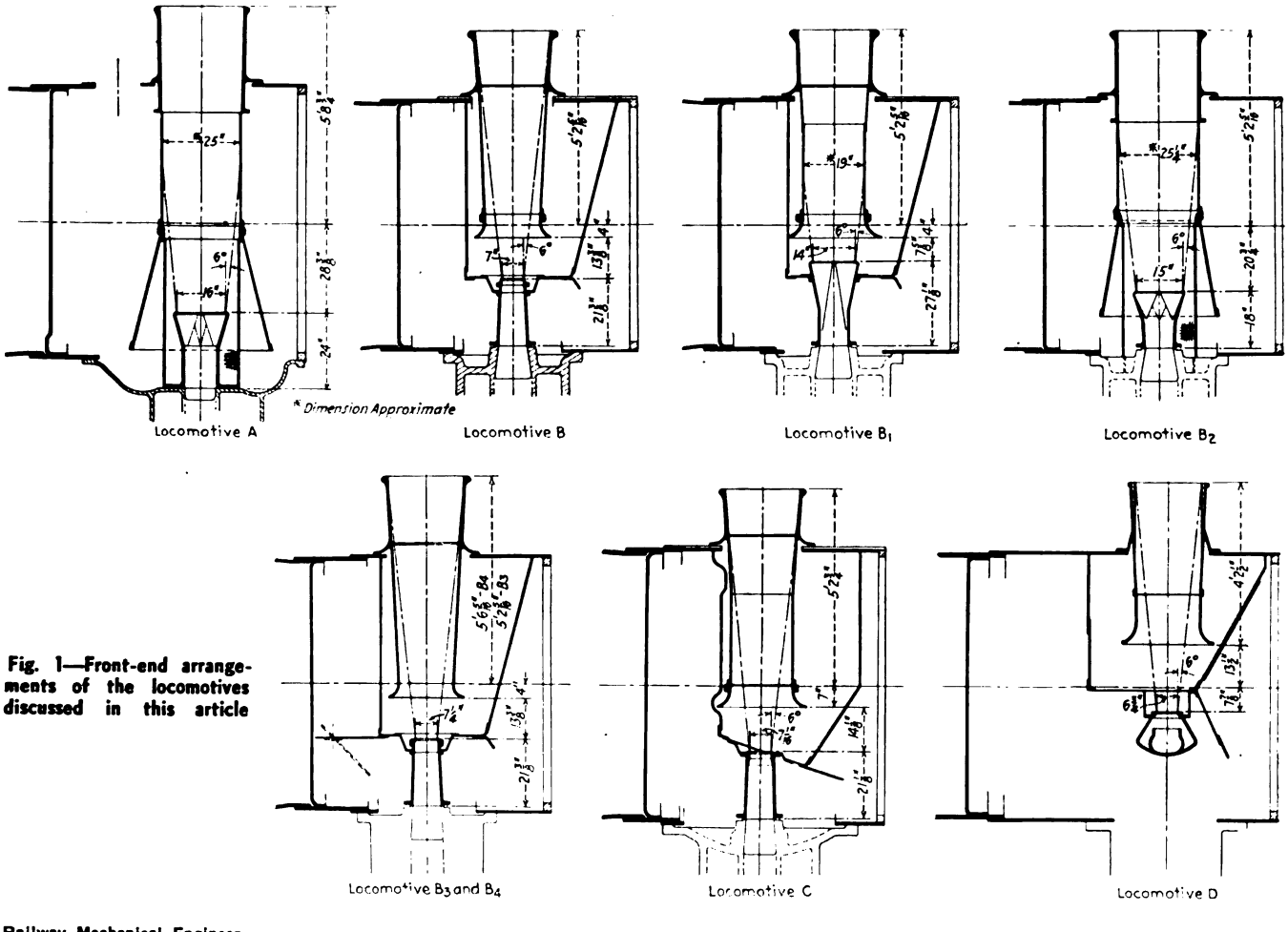


Fig. 1—Front-end arrangements of the locomotives discussed in this article

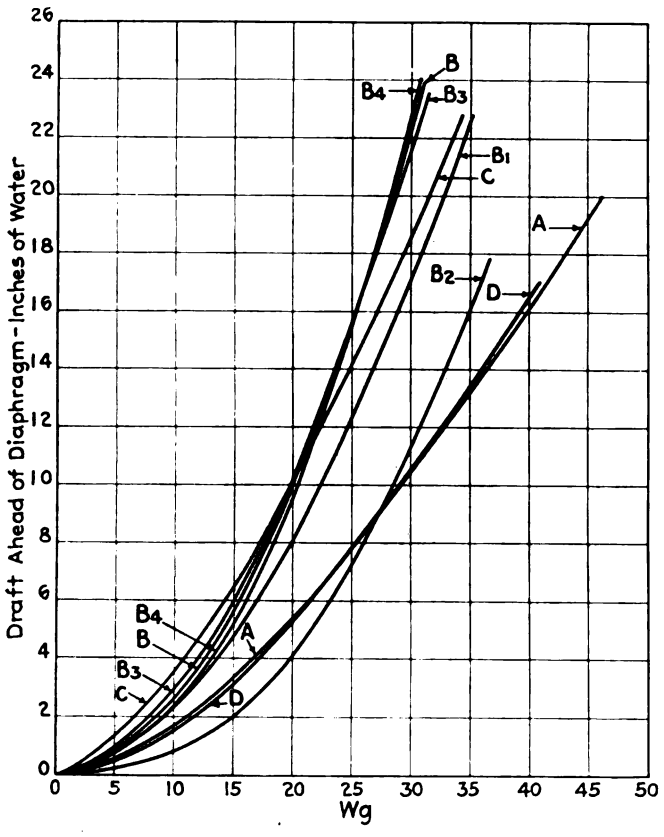


Fig. 2—Relation between Wg and the draft ahead of the diaphragm

istics of the locomotives here discussed are given. Much of the data here used have not been published. The writer wishes to express his gratitude to those who furnished them.

The pertinent data relating to the operation of the drafting apparatus for the eight locomotives under discussion are assembled in Table II. These data are taken from the test records and are assembled in the order of the weight of fuel fired per hour per square

Table I—Principal Proportions and Characteristics of the Eight Locomotives

Locomotive designation	*A*	*B*	B_1	B_2	B_3	B_4	*C*	*D*
Wheel arrangement	4-8-2	4-6-2	4-6-2	4-6-2	4-6-2	2-8-2	2-10-0	2-10-2
Cylinder diameter, in.	27	27	27	27	27	27	30½	27
Piston stroke, in.	30	28	28	28	28	30	32	32
Number of cylinders	2	2	2	2	2	2	2	3
Wheel diameter, in.	72	80	80	80	80	62	62	63½
Working pressure, lb. per sq. in.	250	205	205	205	205	205	250	350
Number of tubes	120	237	237	237	237	237	114	206
Number of flues	170	40	40	40	40	40	200	50
Diameter of tubes, in.	2¼	2¼	2¼	2¼	2¼	2¼	2¼	2¼
Diameter of flues, in.	3½	5½	5½	5½	5½	5½	3¼	5½
Length of tubes and flues, ft.—in.	19—1	19—0	19—0	19—0	19—0	19—0	19—0	23—0
Evaporative heating surface, sq. ft.	4,696	4,041	4,041	4,041	4,041	4,041	4,799	5,192
Combustion chamber length, in.	98	36	36	36	36	36	42	61
Firebox volume, cu. ft.	582	427	427	427	427	427	364	683
Type of superheater	E	A	A	A	A	A	E	A
Grate area, sq. ft.	70	70	70	70	70	70	70	82½
Type of grate	Table	Table	Table	Table	Finger	Finger	Finger	Finger
Stoker or hand fired	Stoker	Hand	Hand	Hand	Hand	Hand	Stoker	Stoker
Feedwater heater	With	None	None	None	None	None	With	With

Note: For front-end arrangement see Fig. 1.

foot of grate surface, column 2. Tests were selected to give the maximum operating range of fuel consumption.

The types of front end, applied to the eight locomotives at the time the tests were conducted, are shown in Fig. 1. It will be observed in the examples here cited that two types of nozzle were used, the Goodfellow and the six-point star. Adequate data were not available for a locomotive using any other type of nozzle. In five of the eight tests here shown, viz., locomotives *B*, B_1, B_2, B_3 and B_4, the boilers and smokeboxes are identical in design. This presents an excellent opportunity for assessing the effect of a change in the structure of the front-end arrangement.

In the operation of the locomotive front end, the gases of combustion generated in the firebox are moved forward over the boiler heating surfaces by the entraining action of the steam jet, which also induces a differential pressure between the firebox and smokebox. The weight of gases moved in a given time is a function of the pressure and weight of steam emerging from the nozzle.

Pressure difference between the interior of the smokebox ahead of the diaphragm and that of the atmosphere, as measured in inches of water, is usually designated as

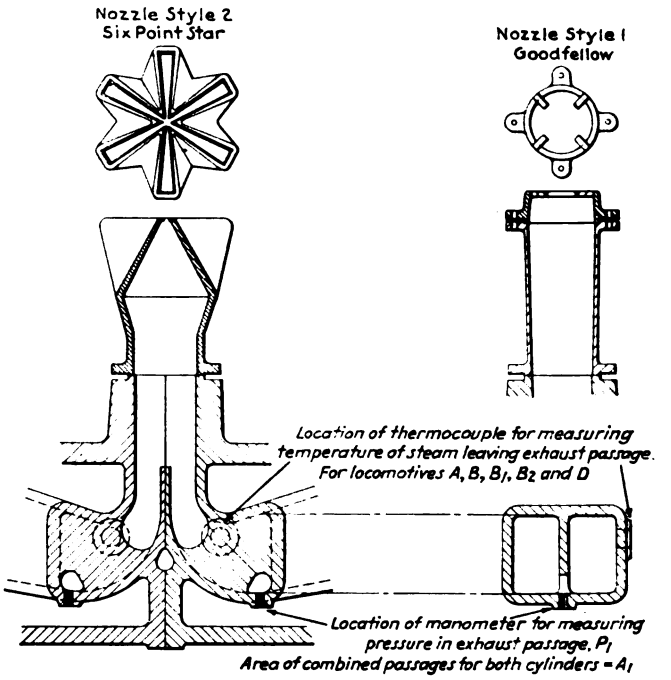


Fig. 3—Location of instruments for measuring pressure and temperature of exhaust steam and types of nozzle used in the tests

the draft. With a given boiler and smokebox arrangement, the weight of gas moved in unit time has a definite relation to the draft, but is not directly proportional, as shown in Fig. 2, for the eight locomotives under discussion. Recent investigators[1] have shown conclusively that the draft, depending as it does on the variable resistance offered to the passage of the gases, is not an accurate measure of the efficiency of a smokebox arrangement. It has been shown that the weight of gas moved per pound of steam issuing from the exhaust nozzle is a more accurate criterion.

Taking into consideration the whole operation of the locomotive or its overall efficiency, the writer would propose another standard for measuring the relative effectiveness of a front-end arrangement, viz., the weight of gas moved over the heating surfaces in unit time per pound pressure of steam exhausted from the cylinders. It is obvious that high back pressure is detrimental to locomotive operation, primarily because it reduces the work done in the cylinders. It will be shown that it is possible to reduce back pressure without decreasing the efficiency of the drafting apparatus.

In view of the importance of the subject, it may be well to review the principles involved in the action of the exhaust steam in drafting a locomotive. The operation of a locomotive exhaust nozzle is subject to the same

Table II—Original Draft Data From Tests of the Eight Locomotives

Loco.	Test No.	Dry fuel, lb. per sq. ft. of grate surface per hr.	Water evaporated, lb. per hr.	Steam exhausted, lb. per hr.	Exhaust-steam conditions: Temp. t_1, deg. F.	Press. P_1, lb. per sq. in., abs.	Press. P_2, lb. per sq. in., abs.	ΔP $P_1 - P_2$	Enthalpy at P_1 and t_1, B.t.u. per lb.	Enthalpy at P_2, B.t.u. per lb.	Specific volume at P_1, cu. ft. per lb.	Specific volume at P_2, cu. ft. per lb.	Draft, in. of water: Ahead of diaphragm	Back of diaphragm	At rear tube sheet	At center of firebox	Speed, r.p.m.	Nominal cutoff, per cent	Mixed gas lb. per sq. ft. grate surface per hr.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	532	67.3	30,620	28,907	320	18.1	14.7	3.4	1200.98	1183.50	25.42	29.84	4.59	...	2.08	1.12	40	70	899.5
	539	80.5	35,170	32,890	347	19.1	14.7	4.4	1213.48	1190.94	24.94	30.47	5.74	...	2.70	1.65	40	80	1057.0
	511	94.4	41,024	39,029	326	20.3	14.7	5.6	1203.36	1176.47	22.83	29.25	6.83	...	3.79	1.64	80	60	1202.0
	520	105.4	44,632	43,080	278	20.2	14.7	5.5	1180.49	1155.63	21.47	27.40	6.90	...	3.75	1.83	320	30	1217.0
	521	108.8	44,655	43,007	278	20.3	14.7	5.6	1180.47	1155.44	21.36	27.36	7.06	...	3.99	2.03	200	40	1215.0
	530	112.8	47,644	45,592	360	21.9	14.7	7.2	1219.21	1185.30	22.09	30.00	8.66	...	4.76	2.43	80	70	1380.0
	519	122.0	48,677	46,815	306	21.5	14.7	6.8	1193.57	1163.39	20.97	28.10	8.45	...	4.70	2.27	160	50	1418.0
	526	128.1	50,210	48,091	288	21.8	14.7	7.1	1184.90	1154.40	20.16	27.32	8.41	...	4.43	2.37	240	40	1313.0
	531	146.9	54,369	51,565	399	24.3	14.7	9.6	1237.25	1192.75	20.88	30.72	10.00	...	4.88	2.95	80	80	1558.0
	527	174.6	63,583	61,193	405	28.1	15.5	12.6	1239.56	1188.26	18.14	28.75	13.42	...	6.22	3.36	120	70	1855.0
	523	231.2	74,339	71,863	420	33.2	18.3	14.9	1246.08	1193.57	15.62	24.75	16.20	...	7.22	4.15	200	60	2208.0
	536	260.9	83,944	80,678	453	38.2	21.1	17.1	1261.33	1207.53	14.10	22.33	18.30	...	7.43	4.54	200	70	2016.0
	537	327.4	89,262	86,584	474	41.4	22.8	18.6	1271.08	1214.96	13.29	21.07	19.95	...	8.04	4.83	200	76	2250.0
B	415A	48.0	27,184	27,135	225	17.8	14.7	3.1	1155.40	1143.37	22.54	26.26	4.88	3.09	2.15	1.29	240	30	725.5
	416A	82.1	41,918	41,853	272	22.9	14.7	8.2	1176.90	1143.61	18.73	26.35	10.88	6.59	4.60	2.64	240	44	1883.5
	418A	107.6	52,826	52,719	319	28.3	15.6	12.7	1198.76	1151.46	16.15	25.60	15.13	9.13	6.15	3.33	240	53	1252.0
	420A	162.8	61,592	61,592	350	33.2	18.3	14.9	1212.54	1163.44	14.32	22.69	17.60	10.95	7.48	3.95	240	61	1360.0
B_1	427A	32.4	30,115	30,115	223	18.1	14.7	3.4	1154.10	1139.50	22.07	25.91	5.18	3.47	2.03	1.13	240	29	836.0
	424A	83.5	42,001	42,001	265	22.0	14.7	7.3	1173.75	1143.58	19.31	26.35	10.70	7.25	4.63	2.34	240	44	1155.0
	425A	118.4	53,956	53,820	310	27.3	15.0	12.3	1194.34	1147.14	16.55	26.21	15.79	10.35	6.52	3.27	240	53	1440.0
	430A	127.1	53,796	53,712	307	26.8	14.7	12.1	1197.87	1151.36	16.79	26.68	15.95	10.38	6.22	3.51	240	53	1447.5
	431A	151.6	63,058	62,865	344	31.3	17.2	14.1	1209.96	1161.04	15.08	23.90	19.59	12.30	7.01	4.40	240	60	1687.5
	429A	186.3	70,350	70,286	370	36.8	20.3	16.5	1221.62	1174.01	13.23	20.96	21.85	13.26	7.04	4.56	240	67	1780.0
B_2	438A	49.4	29,328	29,328	226	17.2	14.7	2.5	1156.15	1144.52	23.38	26.38	2.86	...	1.88	1.09	240	26	780.5
	434A	78.4	40,498	40,420	248	19.3	14.7	4.6	1166.24	1145.79	21.50	26.50	4.80	...	2.93	1.67	320	35	1205.0
	435A	86.8	44,640	44,601	261	20.5	14.7	5.8	1172.23	1147.03	20.63	26.66	6.47	...	4.35	2.75	240	44	1160.0
	436A	109.2	55,576	55,660	301	24.7	14.7	10.0	1190.54	1150.04	18.09	26.95	9.33	...	5.95	3.52	240	52	1406.0
	437A	140.6	64,925	64,754	328	28.9	15.9	13.0	1202.66	1155.34	16.00	25.36	11.55	...	6.96	4.14	240	59	1593.0
	441A	148.1	64,831	64,664	340	28.5	15.7	12.8	1208.50	1159.80	16.49	26.12	10.94	...	5.87	3.71	240	61	1650.0
	440A	184.2	72,759	72,620	365	32.7	18.0	14.7	1219.85	1170.40	14.82	23.50	12.75	...	6.76	4.06	240	66	1635.0
	439A	185.7	72,049	71,990	369	32.5	17.9	14.6	1221.77	1172.87	14.84	23.51	13.45	...	7.36	4.91	240	67	1594.0
B_3	4051	28.4	19,502	19,184	217	16.2	14.7	1.5	1152.00	1144.94	24.58	26.45	2.0	1.5	...	0.50	320	16	482.0
	4020	35.6	22,499	20,372	218	16.5	14.7	1.8	1152.40	1141.70	24.08	26.31	2.6	1.8	...	0.50	160	24	482.5
	4050	48.5	28,893	28,699	225	18.9	14.7	4.2	1154.90	1136.85	21.19	25.70	4.8	3.1	...	1.00	320	23	652.0
	4059	67.2	37,803	37,803	246	21.6	14.7	6.9	1164.60	1136.60	19.13	25.73	8.1	5.3	...	1.30	240	38	914.5
	4013	89.5	44,598	43,715	255	23.3	14.7	8.6	1168.43	1134.73	17.95	25.58	10.3	6.7	...	2.10	200	45	937.0
	4069	124.4	57,586	53,597	322	26.1	14.7	11.4	1200.10	1154.29	17.59	27.37	15.1	10.1	...	2.80	320	51	1037.0
	4068	130.4	56,700	55,924	317	28.0	15.4	12.6	1197.56	1150.26	16.28	25.79	14.	9.0	...	2.70	120	69	1266.5
	4049	143.4	59,953	58,170	332	30.1	16.6	13.5	1204.50	1156.45	15.45	24.50	16.3	9.2	...	2.10	280	53	...
	4054	170.5	65,400	65,319	343	33.8	18.6	15.2	1208.96	1160.06	13.93	22.05	18.8	11.7	...	2.90	200	60	1495.0
B_4	3923	56.1	30,594	30,594	227	19.6	14.7	4.9	1155.87	1135.01	20.51	25.60	4.8	3.6	...	1.30	120	43	659.5
	3932	76.3	38,628	38,413	249	22.2	14.7	7.5	1165.54	1135.38	18.67	25.63	7.9	5.8	...	1.60	100	55	863.2
	3921	86.8	44,708	44,584	266	24.2	14.7	9.5	1173.72	1134.67	17.56	25.79	9.8	6.6	...	1.70	160	52	1025.0
	3926	96.3	45,450	44,889	275	24.3	14.7	9.6	1177.77	1140.08	17.70	26.07	10.6	7.5	...	2.20	170	53	1045.0
	3945	112.4	47,508	47,508	306	25.1	14.7	10.4	1192.84	1151.44	17.92	27.08	10.8	7.6	...	2.60	120	61	1037.5
	3928	127.8	55,760	55,705	327	28.8	15.8	13.0	1202.39	1154.12	16.05	25.43	15.1	10.5	...	2.50	170	62	1214.0
	3927	148.7	58,640	58,256	326	30.6	16.8	13.8	1201.36	1153.37	15.06	23.86	16.1	10.8	...	2.90	160	62	1342.5
	3931	169.2	58,860	58,860	323	30.3	16.7	13.6	1199.79	1153.41	15.14	24.00	16.5	11.8	...	3.50	120	73	1345.0
C	5935	56.7	28,050	27,290	244	18.7	14.7	4.0	1164.45	1146.40	22.07	26.55	6.2	4.2	...	1.20	40	49	692.5
	5919	68.4	32,930	31,844	235	19.7	14.7	5.0	1159.62	1138.37	20.65	25.86	5.8	4.4	...	1.20	80	39	778.0
	5940	79.9	33,300	32,298	249	19.7	14.7	5.0	1166.62	1144.96	21.09	26.40	7.7	5.3	...	1.10	40	56	712.0
	5971	97.1	41,400	40,195	242	21.7	14.7	7.0	1162.42	1144.96	18.91	25.51	8.8	6.2	...	1.50	120	40	897.0
	5939	103.0	41,600	40,517	252	22.7	14.7	8.0	1167.09	1135.74	18.35	25.65	9.2	7.1	...	1.30	60	57	899.0
	5933	127.1	49,500	48,310	299	25.7	14.7	11.0	1189.28	1146.28	17.33	26.65	12.9	9.6	...	1.60	80	57	1323.0
	6123	212.1	57,900	56,058	280	30.7	16.9	13.8	1178.69	1134.57	14.06	22.28	16.5	12.0	...	2.20	160	50	1310.0
	5973	228.5	58,400	57,184	298	28.7	15.8	12.9	1188.19	1142.79	15.46	24.50	13.9	10.7	...	2.20	180	52	1336.0
D	7918	44.0	27,700	26,360	224	18.2	14.7	3.5	1154.76	1139.11	22.00	25.90	3.2	2.3	...	0.62	160	52-28	670.0
	7915	62.1	35,970	34,446	236	21.0	14.7	6.3	1159.67	1134.17	19.36	25.49	5.0	3.7	...	1.18	160	64-34	835.0
	7924	75.4	41,380	39,208	286	23.3	14.7	8.6	1183.59	1148.23	18.79	26.80	6.2	4.6	...	1.33	200	62-36	906.0
	7907	87.0	47,210	44,201	248	25.8	14.7	11.1	1164.62	1124.70	15.99	24.66	7.5	5.4	...	1.35	120	81-54	1044.0
	7925	112.2	55,560	52,925	317	28.9	15.9	13.0	1197.36	1150.26	15.72	24.97	8.6	6.3	...	1.59	200	71-47	1266.0
	7927	135.2	62,180	59,746	313	34.4	18.9	15.5	1194.31	1147.11	13.13	20.80	10.6	7.7	...	1.99	200	83-55	1296.0
	7923	143.4	61,610	59,148	308	34.5	19.0	13.5	1191.76	1145.66	13.00	20.60	10.7	8.0	...	2.31	200	82-52	1306 5

laws that govern the operation of any steam nozzle, regardless of the fact that its contour does not show the refinement of design that characterizes the turbine or ejector nozzle. There are in use on locomotives a variety of nozzle types from the plain circular form to the complicated grid and star types. The great majority of the steam locomotives in this country are equipped with the plain round nozzle. For the locomotives under discussion, the type of nozzle used is indicated more or less diagrammatically by Fig. 3. This figure serves also to show the location of the instruments used for measuring the pressure and temperature of the exhaust steam in the cylinder exhaust passages.

Table III—Nomenclature

A_1 = area of cylinder exhaust passage, sq. ft. at point where measurements P_1 and t_1 are taken.
A_2 = area of exhaust nozzle outlet, sq. ft.
P_0 = pressure in smokebox, ahead of diaphragm.
P_1 = steam pressure in exhaust passage, at A_1, lb. per sq. in., abs.
P_2 = steam pressure in exhaust nozzle, at A_2, lb. per sq. in., abs.
ΔP = $(P_1 - P_2)$*.
t_1 = temperature of steam at A_1, deg. F.
V_1 = specific volume of exhaust steam at A_1, cu. ft. per lb.
V_2 = specific volume of exhaust steam at A_2, cu. ft. per lb.
H_1 = enthalpy of steam at A_1, B.t.u. per lb.
H_2 = enthalpy of steam at A_2, B.t.u. per lb.
ΔH = $(H_1 - H_2)$.
M_t = theoretical weight of steam flowing through nozzle, lb. per sec.
M = actual weight of steam through nozzle, from tests, lb. per sec.
M_0 = mean calculated weight of steam flowing through nozzle, lb. per sec.
W_t = theoretical velocity of flow through nozzle, ft. per sec.
W = actual velocity of flow through nozzle, ft. per sec.
$C = M_0 / M_t = W / W_t$.
C_t = proportion of heat in steam appearing at nozzle.
Z = correction factor for initial velocity of steam at A_1.
W_g = weight of gas passing through boiler and smokebox, lb. per sec.
C_s = weight of gas per lb. of steam flowing through nozzle, lb.
C_g = weight of gas generated per lb. of coal burned, lb.
C_b = ratio of coal burned to coal fired.
$W_t = C_g C_b$ = lb. of gas per lb. of coal fired.
G = lb. of coal fired per hr. per sq. ft. of grate surface.
R_0 = grate area, sq. ft.
K = calorific value of dry fuel, B.t.u. per lb.
F = evaporative efficiency of boiler.
m and n = constants used in determining boiler efficiency.
x and y = constants used in determining coefficient C.
E = total evaporation of boiler, lb. per hr.
E_1 = total steam flowing through nozzle, lb. per hr.
n and n_1 = constants used in relating M_0 to P.
$\propto$ = varies as.
a = flare angle of steam jet.

* Values of ΔP from 0 to 12, inclusive, equal gage pressure.
Values of ΔP over 12 equal $(P_1 - 0.55 P_1)$.
When ΔP exceeds 12, $P_1 = \{ [15.3 (\Delta P - 12)] / 6.9 \} + 26.7$.

In the tests of locomotives B_3, B_4 and C, the temperature t_1 of the exhaust steam was measured with mercury thermometers placed near the cylinders, consequently the readings are thought to be too high. For the remaining tests, the steam temperature was recorded by thermocouples located in the exhaust passages as shown in Fig. 3. For the earlier tests, the exhaust pressure P_1 was read from Bourdon gages fitted with a retard device to control the violent fluctuations in pressure. With this device it was found difficult to establish the true mean pressure. For the later tests, a mercury U-gage or manometer was used as recommended by the A. S. M. E. Power Test Code.

The symbols used in this discussion are shown in Table III.

The standard equation for determining the velocity of steam flow per second through a nozzle, where the initial velocity is not a factor, is:

$$W_t = 223.7 \sqrt{\Delta H} \quad \ldots\ldots (1)$$

In the locomotive exhaust passage, the initial velocity of the steam at A_1, Fig. 3, is relatively high and must be accounted for. The equation then becomes:

$$W_t = 223.7 \sqrt{\frac{\Delta H}{1 - \left(\frac{A_2}{A_1}\right)^2 \left(\frac{V_1}{V_2}\right)^2}} \quad \ldots\ldots (2)$$

To facilitate calculation by slide rule, equation (2) can be more conveniently stated as:

$$W_t = 223.7 \sqrt{\Delta H} / \sqrt{Z} \quad \ldots\ldots (3)$$

where

$$Z = 1 - \left(\frac{A_2}{A_1}\right)^2 \left(\frac{V_1}{V_2}\right)^2 \quad \ldots\ldots (4)$$

The actual velocity of discharge through the nozzle is reduced by friction and other losses and is always less than W_t. Then

$$W = W_t C \quad \ldots\ldots (5)$$

The theoretical weight of steam per second passing through the nozzle is

$$M_t = \frac{223.7 A_2 \sqrt{\Delta H}}{V_2 \times \sqrt{Z}} \quad \ldots\ldots (6)$$

or

$$M_t = W_t A_2 / V_2 \quad \ldots\ldots (7)$$

The mean calculated weight of steam flowing through the nozzle per second is

$$M_0 = M_t C \quad \ldots\ldots (8)$$

The product of equations (3), (4) and (5), as calculated from the test data for the eight locomotives under discussion, is shown in Table IV. These tables also give the values of A_1, A_2, and ΔH, as well as indicating the type of nozzle employed.

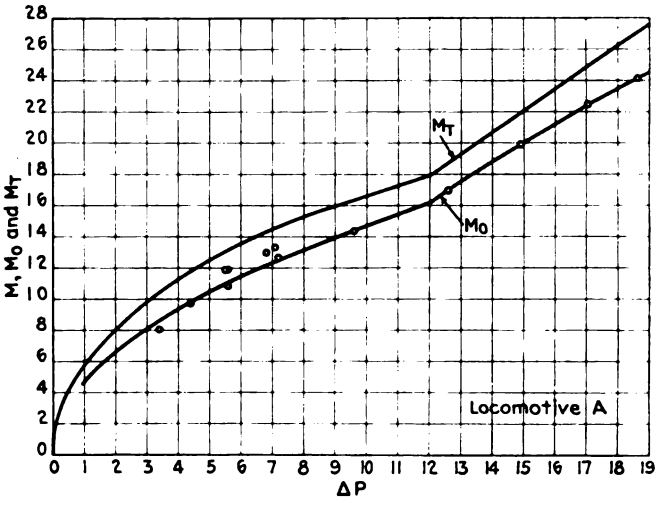


Fig. 4—Theoretical and actual steam flow per second as related to ΔP for locomotive A

The upper curve in Fig. 4 represents the value M_t as related to the pressure difference ΔP, for the locomotive A. Curves having the same characteristics were constructed for the eight locomotives. Locomotive A was selected for illustration because this test had a wider range than the others and is the most recent.

The lower curve in Fig. 4 represents the mean calculated value of the weight of steam per second M_0 passing through the nozzle. It will be noted that this agrees with the actual test values M, as represented by the small circles. The nozzle coefficient is

$$C = M_0 / M_t \quad \ldots\ldots (9)$$

It will be seen from Fig. 4 that when ΔP reaches a value of 12, there is an abrupt change in the contour of the curves M_t and M_0. This is caused by the difference in the value of P_2, which from 0 to 12 is 14.7 lb., and

Table IV—Calculated Data Based on Tests of the Eight Locomotives

1	2	3	4	5	6	7[a]	8[b]	9	10	11	12[c]
Test No.	Type of nozzle	Area of steam passage in cylinder, A_1 in Fig. 3, sq. ft.	Area of nozzle outlet, A_2 in Fig. 3, sq. ft.	Heat drop ΔH between A_1 and and A_2, B.t.u. per lb.	M, lb.	W, ft. per sec.	W_t, ft. per sec.	$\frac{W}{W_t}$	$\left(\frac{A_2}{A_1}\right)^2$	$\left(\frac{V_1}{V_2}\right)^2$	z
Locomotive *A*:											
532	S	0.959	0.321	17.48	8.03	746	976	0.764	0.1120	0.726	0.9186
539	S	0.959	0.321	22.54	9.13	866	1104	0.785	0.1120	0.671	0.9248
511	S	0.959	0.321	26.89	10.84	988	1178	0.839	0.1120	0.610	0.9316
520	S	0.959	0.321	24.86	11.96	1020	1156	0.882	0.1120	0.615	0.9311
521	S	0.959	0.321	25.03	11.95	1018	1160	0.878	0.1120	0.612	0.9314
530	S	0.959	0.321	33.91	12.65	1182	1344	0.880	0.1120	0.543	0.9392
519	S	0.959	0.321	30.18	13.00	1138	1269	0.897	0.1120	0.558	0.9375
526	S	0.959	0.321	30.50	13.35	1136	1275	0.891	0.1120	0.544	0.9390
531	S	0.959	0.321	44.50	14.32	1370	1532	0.984	0.1120	0.461	0.9484
527	S	0.959	0.321	51.30	16.98	1520	1638	0.928	0.1120	0.398	0.9553
523	S	0.959	0.321	52.51	19.96	1538	1658	0.928	0.1120	0.398	0.9553
536	S	0.959	0.321	53.80	22.41	1559	1679	0.928	0.1120	0.398	0.9553
537	S	0.959	0.321	56.12	24.04	1577	1713	0.921	0.1120	0.398	0.9553
Locomotive *B*:											
415A	G	1.286	0.250	12.03	7.54	792	787	1.006	0.0378	0.738	0.9721
416A	G	1.286	0.250	33.29	11.63	1225	1303	0.941	0.0378	0.505	0.9809
418A	G	1.286	0.250	47.30	14.64	1498	1550	0.967	0.0378	0.398	0.9849
420A	G	1.286	0.250	49.10	17.10	1551	1579	0.983	0.0378	0.398	0.9849
Locomotive B_1:											
427A	S	1.286	0.280	14.60	8.34	780	870	0.896	0.0474	0.726	0.9656
424A	S	1.286	0.280	30.17	11.67	1098	1245	0.882	0.0474	0.537	0.9745
425A	S	1.286	0.280	47.20	14.96	1400	1550	0.904	0.0474	0.398	0.9811
430A	S	1.286	0.2948	46.51	14.92	1350	1540	0.877	0.0526	0.398	0.9790
431A	S	1.286	0.2948	48.92	17.46	1415	1581	0.895	0.0526	0.398	0.9730
429A	S	1.286	0.280	49.32	19.52	1461	1585	0.922	0.0474	0.398	0.9811
Locomotive B_2:											
438A	S	1.286	0.3335	11.63	8.15	644	784	0.822	0.067	0.800	0.9462
434A	S	1.286	0.3335	20.45	11.24	893	1035	0.863	0.067	0.659	0.9557
435A	S	1.286	0.3335	25.20	12.40	992	1139	0.871	0.067	0.600	0.9729
436A	S	1.286	0.3335	40.50	15.46	1249	1445	0.865	0.067	0.403	0.9698
437A	S	1.286	0.3335	47.32	18.00	1368	1560	0.877	0.067	0.398	0.9732
441A	S	1.286	0.3335	48.70	17.97	1408	1583	0.890	0.067	0.398	0.9732
440A	S	1.286	0.3335	49.45	20.20	1422	1594	0.893	0.067	0.398	0.9732
439A	S	1.286	0.3335	48.90	19.99	1408	1585	0.889	0.067	0.398	0.9732
Locomotive B_3:											
4051	G	1.196	0.2655	7.06	5.32	530	607	0.872	0.0493	0.861	0.9576
4020	G	1.196	0.2655	8.42	5.66	561	748	0.750	0.0493	0.837	0.9588
4050	G	1.196	0.2655	18.05	7.97	772	967	0.798	0.0493	0.679	0.9660
4059	G	1.196	0.2655	28.00	10.50	1018	1200	0.849	0.0493	0.553	0.9727
4013	G	1.196	0.2655	33.70	12.15	1170	1315	0.890	0.0493	0.493	0.9757
4069	G	1.196	0.2655	45.81	14.88	1535	1530	1.004	0.0493	0.413	0.9796
4018	G	1.196	0.2655	47.30	15.63	1507	1554	0.976	0.0493	0.398	0.9804
4049	G	1.196	0.2655	48.05	16.15	1490	1566	0.952	0.0493	0.398	0.9804
4054	G	1.196	0.2655	48.90	18.14	1506	1580	0.954	0.0493	0.398	0.9804
Locomotive B_4:											
3923	G	1.196	0.2665	20.86	8.49	816	1033	0.790	0.0497	0.642	0.9681
3932	G	1.196	0.2665	30.16	10.68	1027	1245	0.825	0.0497	0.531	0.9736
3921	G	1.196	0.2665	37.05	12.38	1197	1377	0.797	0.0497	0.464	0.9763
3926	G	1.196	0.2665	37.69	12.47	1220	1390	0.878	0.0497	0.461	0.9771
3943	G	1.196	0.2665	41.40	13.20	1342	1455	0.810	0.0497	0.438	0.9782
3928	G	1.196	0.2665	48.27	15.47	1477	1570	0.941	0.0497	0.398	0.9802
3927	G	1.196	0.2665	47.99	16.20	1450	1565	0.927	0.0497	0.398	0.9802
3931	G	1.196	0.2665	46.38	16.35	1472	1538	0.957	0.0497	0.398	0.9802
Locomotive *C*:											
5935	G	1.188	0.2495	18.05	7.58	807	965	0.836	0.0441	0.692	0.9695
5919	G	1.188	0.2495	21.25	8.84	916	1045	0.876	0.0441	0.635	0.9713
5940	G	1.188	0.2495	21.66	8.96	948	1055	0.898	0.0441	0.635	0.9719
5971	G	1.188	0.2495	27.70	11.15	1140	1191	0.957	0.0441	0.549	0.9758
5939	G	1.188	0.2495	31.35	11.25	1157	1266	0.914	0.0441	0.512	0.9774
5933	G	1.188	0.2495	43.00	13.41	1432	1480	0.968	0.0441	0.422	0.9814
6123	G	1.188	0.2495	44.12	15.57	1390	1496	0.930	0.0441	0.398	0.9824
5973	G	1.188	0.2495	45.40	15.87	1558	1522	1.023	0.0441	0.398	0.9824
Locomotive *D*:											
7918	G	0.884	0.2308	15.65	7.32	822	908	0.905	0.0681	0.722	0.9508
7915	G	0.884	0.2308	25.50	9.56	1056	1152	0.916	0.0681	0.577	0.9607
7924	G	0.884	0.2308	35.36	10.89	1265	1353	0.935	0.0681	0.429	0.9665
7907	G	0.884	0.2308	39.92	12.28	1312	1435	0.915	0.0681	0.491	0.9714
7925	G	0.884	0.2308	47.10	14.70	1590	1557	1.022	0.0681	0.398	0.9728
7927	G	0.884	0.2308	47.20	16.59	1496	1558	0.960	0.0681	0.398	0.9728
7923	G	0.884	0.2308	46.10	16.43	1466	1540	0.952	0.0681	0.398	0.9728

Notes: S refers to six-point star nozzle and G refers to Goodfellow nozzle. [a] See equation (5). [b] See equation (3). [c] See equation (4).

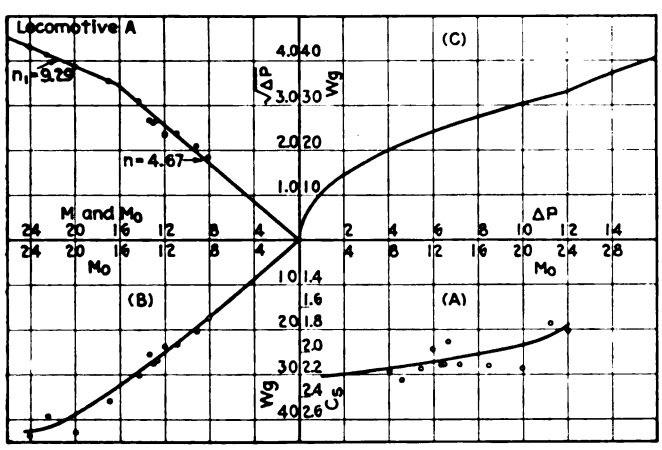


Fig. 5—Steam flow per second as related to $\sqrt{\Delta P}$, weight of gas per pound of steam, weight of gas flow per second, and gas flow as related to ΔP for locomotive *A*

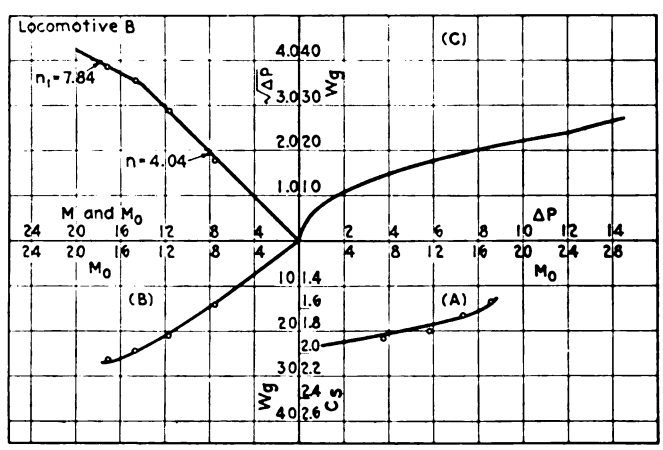


Fig. 6—Steam flow per second as related to $\sqrt{\Delta P}$, weight of gas per pound of steam, weight of gas flow per second, and gas flow as related to ΔP for locomotive *B*

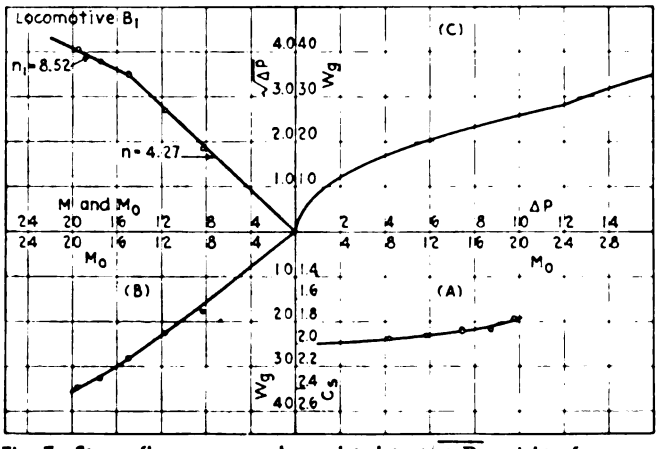


Fig. 7—Steam flow per second as related to $\sqrt{\Delta P}$, weight of gas per pound of steam, weight of gas flow per second, and gas flow as related to ΔP for locomotive B_1

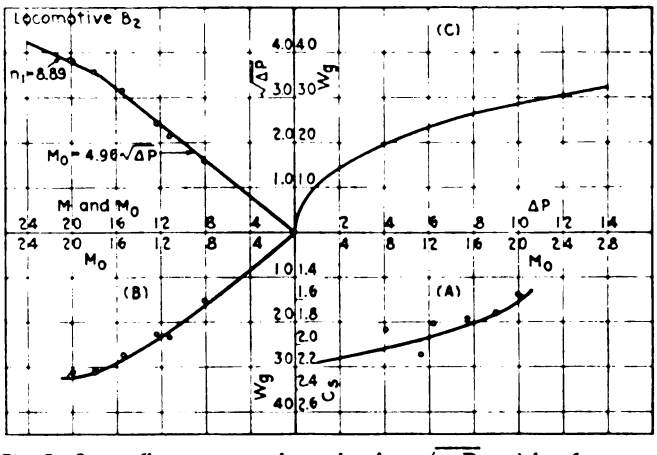


Fig. 8—Steam flow per second as related to $\sqrt{\Delta P}$, weight of gas per pound of steam, weight of gas flow per second, and gas flow as related to ΔP for locomotive B_2

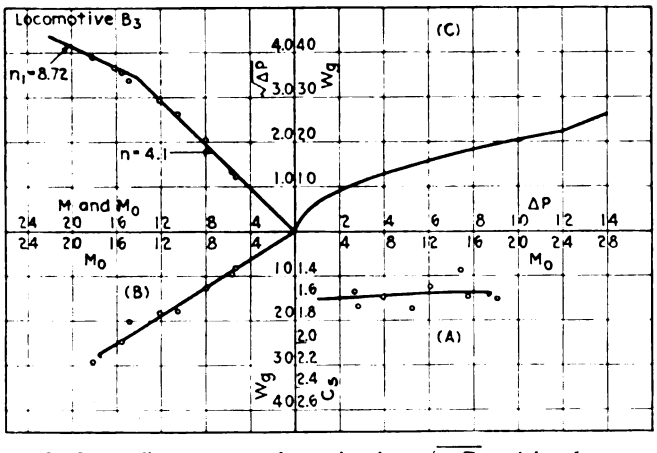


Fig. 9—Steam flow per second as related to $\sqrt{\Delta P}$, weight of gas per pound of steam, weight of gas flow per second, and gas flow as related to ΔP for locomotive B_3

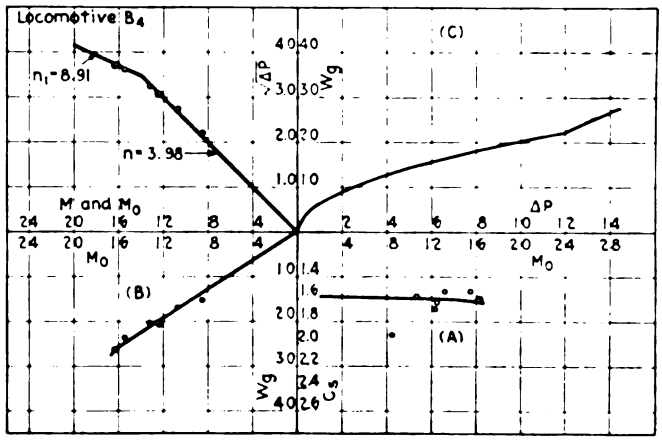


Fig. 10—Steam flow per second as related to $\sqrt{\Delta P}$, weight of gas per pound of steam, weight of gas flow per second, and gas flow as related to ΔP for locomotive B_4

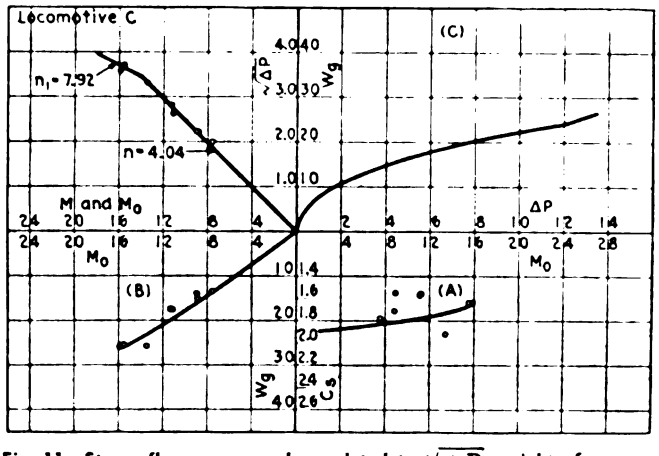


Fig. 11—Steam flow per second as related to $\sqrt{\Delta P}$, weight of gas per pound of steam, weight of gas flow per second, and gas flow as related to ΔP for locomotive C

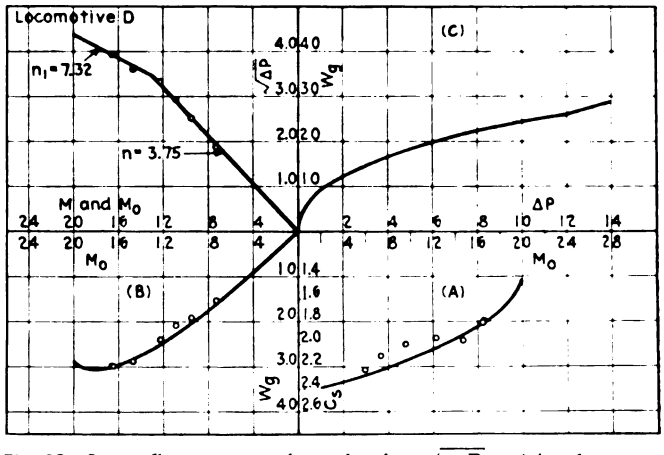


Fig. 12—Steam flow per second as related to $\sqrt{\Delta P}$, weight of gas per pound of steam, weight of gas flow per second, and gas flow as related to ΔP for locomotive D

above 12 is 0.55 P_1. This critical ratio for the flow of a fluid through an orifice is well known and enters into all nozzle calculations.

It was found by experiment that for all the locomotives being considered, there is a straight-line relation between M_o and $\sqrt{\Delta P}$. From zero to the critical pressure

$$M_o = n\sqrt{\Delta P} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

while beyond the critical pressure

$$M_o = n_1(\sqrt{\Delta P} - \sqrt{12}) + n\sqrt{12} \quad \ldots\ldots\ldots\ldots\ldots (11)$$

For the majority of the tests cited, the value of ΔP does not extend much beyond 12. In these cases it is somewhat difficult to establish with certainty the value of the constant n_1, although it evidently approximates 2 n. For locomotive A, the range of the test was so extensive that the value of n_1 is easily established at 1.99 n.

The relation between M_o and ΔP is shown in Figs. 5 to 12, inclusive, for all of the eight locomotives. The actual steam flow M is also indicated in these figures by small circles. It is evident from these exhibits that be-

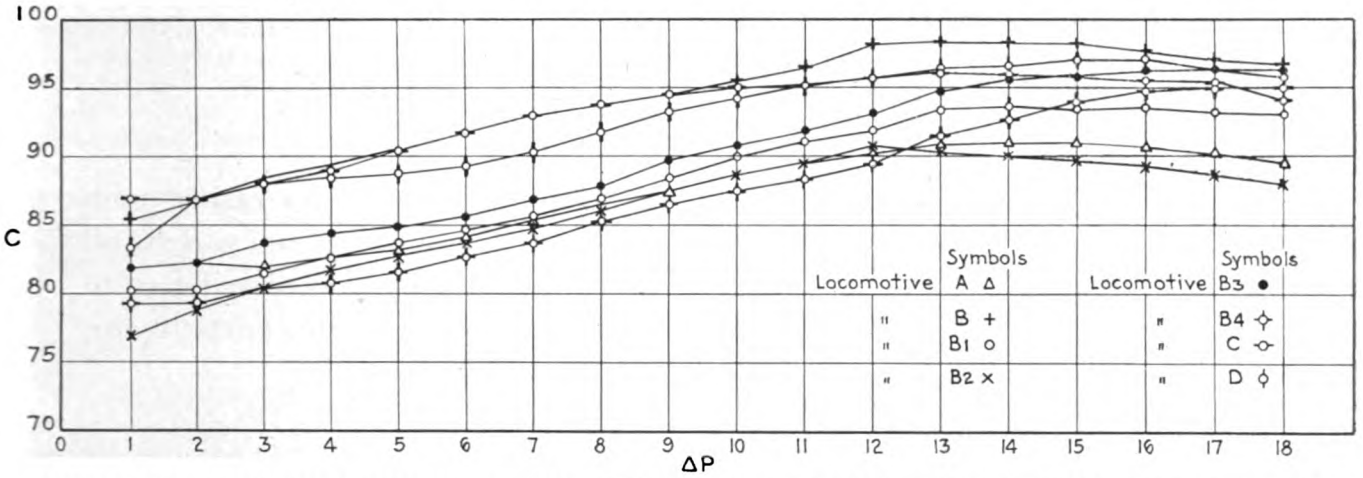


Fig. 13—Value of coefficient *C* in per cent, as related to $\triangle P$, for tests of the eight locomotives—Actual *C* = values given ÷ 100

yond the critical pressure the value of $\triangle P$ increases with the steam flow at a much lower rate than obtains below the critical pressure.

The coefficient C varies rather widely for the designs of locomotives tested; this is indicated by Fig. 13. As a rule, the value of C tends to increase with the flow up to the critical pressure. Beyond that point it either is constant or diminishes. The maximum variation for any given value of $\triangle P$ is approximately 10 per cent. The coefficient appears to vary inversely as the nozzle area, especially beyond the critical pressure. The writer has found it impossible to establish from the data available the law governing the variation in the value of C. There is nothing very definite in technical literature bearing on the probable value of C, in such a case. It can be closely estimated, for the tests cited, by the equation:

$$C = x - (yA_2) \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

in which the constants x and y, as related to $\triangle P$, are given in Fig. 14.

Table V—Calculated Data for Plotting Fig. 4

1	2	3	4[a]	5[b]	6[c]	7	8	9	10[d]	11[e]	12[f]	13[g]
P_1	P_2	$\triangle P$	t_1	V_1	V_2	$\triangle H$	$\sqrt{\triangle H}$	$(V_1V_2)^2$	Z	M_t	M_o	C
15.0	14.70	0.30	296	29.73	30.20	1.683	1.298	0.969	0.8915	3.27	....	....
16.0	14.70	1.30	303	28.13	30.05	6.690	2.587	0.876	0.9081	6.52	5.29	81.14
18.0	14.70	3.30	317	25.45	29.74	16.750	4.092	0.733	0.9178	10.31	10.31	82.06
20.0	14.70	5.30	330	23.29	29.52	25.550	5.054	0.622	0.9301	12.76	10.69	83.78
23.0	14.70	8.30	350	20.26	29.30	37.620	6.137	0.501	0.9439	15.48	13.47	87.02
26.0	14.70	11.30	370	18.81	29.19	48.200	6.941	0.415	0.9539	17.50	15.85	90.51
26.7	14.70	12.00	374	18.41	29.14	50.690	7.119	0.398	0.9554	17.95	16.39	91.33
27.0	14.85	12.15	375	18.22	28.85	50.730	7.120	0.398	0.9554	18.12	16.53	91.23
29.0	15.95	13.05	382	17.09	27.07	50.900	7.138	0.398	0.9554	19.36	17.60	90.94
32.0	17.60	14.40	390	15.63	24.78	51.400	7.170	0.398	0.9554	21.27	19.26	90.53
34.0	18.70	15.30	397	14.82	23.48	52.200	7.222	0.398	0.9554	22.60	20.40	90.20
42.0	23.10	18.90	421	12.32	19.53	53.320	7.301	0.398	0.9554	27.50	24.50	89.05

Notes: [a] Mean test results. [b] Values taken from steam tables. [c] See equation (13). [d] See equation (4). [e] See equation (6). [f] See equation (9). [g] See equation (12). For definition of terms in column heads and their units, see Table III.

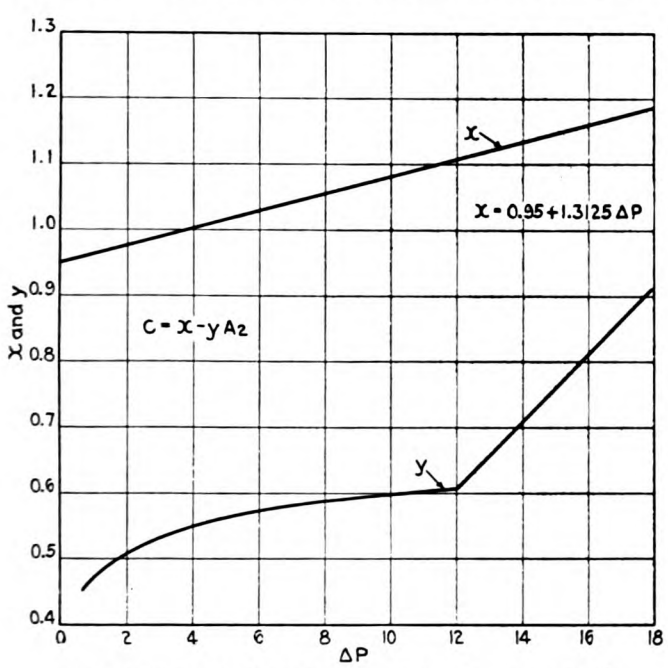


Fig. 14—Constants for determining value of coefficient *C*

The loss of energy in the exhaust passages and nozzle is due in part to friction between the steam and the enclosing walls, but is more largely due to the divergence of the expansion of the steam from the adiabatic or theoretical expansion of steam in a nozzle.

The standard steam tables are based on the assumption that when the temperature of superheated steam falls to the saturation point, it immediately begins to condense. Experiments [3] have proven that this is not true of expansion in a nozzle. Here the steam may be cooled well below the saturation temperature before condensation begins. The steam in this region will follow the law of expansion for superheated steam. This fact must be taken into consideration in establishing the values of V_2 and H_2. To determine these values under the condition of undercooling the following equations have been proposed:[4]

$$V_2 = V_1\left(\frac{P_1}{P_2}\right)^{0.77} \quad \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

$$H_2 = H_1 - 0.802\,[(P_1 V_1) - (P_2 V_2)] \quad \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

Equations (13) and (14) have been used throughout

[3] "Supersaturated Steam," by John I. Yellott, Jr., Trans. A. S. M. E., June, 1934, vol. 56, paper FSP-56-7, page 411.
[4] Ibid, Appendix No. 2.

(Continued on page 18)

Service Mileage Increased by

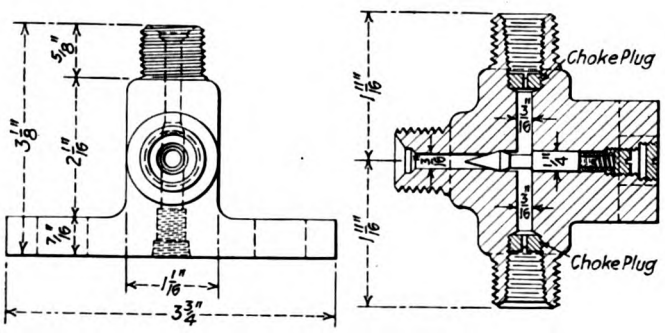
Force-Feed Oil Lubrication

Lehigh Valley is operating over 300 locomotives on which oil under pressure is distributed to the major wearing parts by the use of dividers

IN September of last year the Lehigh Valley unwheeled a Class L-5 eight-wheel switching locomotive, No. 3137, at the Perth Amboy, N. J. engine terminal for tire turning. This switcher was turned out of the Sayre, Pa. system shops in August, 1933, after receiving Class 3 repairs and had been in service for four years and one month, accumulating a total mileage of 64,712.

This locomotive is one of a number of the eight-wheel and Mikado type used in switching service on the Lehigh Valley that are equipped with force-feed oil lubrication for the principal working parts. The oil is supplied to the feed lines by either Nathan or Detroit mechanical lubricators and is distributed to the various points by means of two-, three- or four-way oil dividers of the type shown in one of the illustrations. These oil dividers were developed on the Lehigh Valley and are covered by patents.

The divider shown in the illustration is one of the two-way type. The oil enters from the lubricator under pressure and forces the needle valve open to admit it to the passage leading to the outlets. The spring controlling the action of the needle valve is set, for most locations, at 50 lb. per sq. in. The amount of oil passing



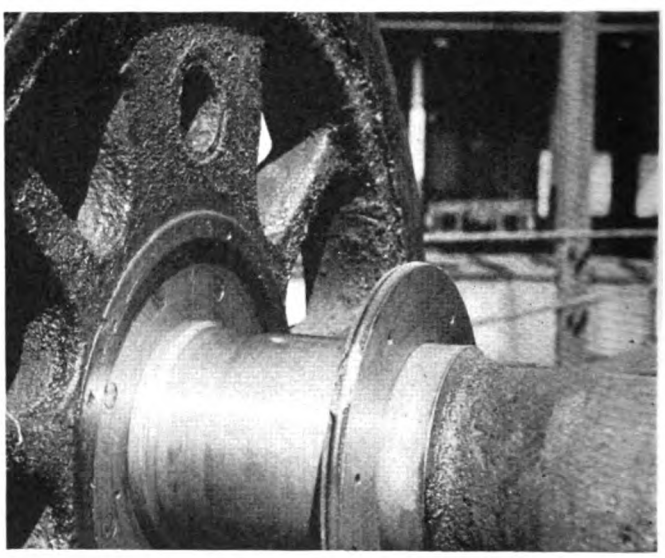
Details of a two-way divider

from the outlets of the dividers is controlled by the diameter of the hole in the choke plugs shown at the ends of the outlet passage. In the case of the type illustrated, the hole in the choke plug is 1/16 in. diameter.

On the eight-wheel switcher, the locations oiled are indicated in the diagrammatic sketch. Oil is supplied from an eight-feed mechanical lubricator and by means of dividers 21 points on the locomotive are oiled. One feed supplies two locations on the guides; four feeds supply eight locations on the four drivers—four crown brasses and four hub liners; one feed of the lubricator supplies the air compressor; the remaining two feeds supply four locations in the valves and cylinders. Dividers of the type described are not used on the air pump, valves or cylinders where lubrication is against high steam pressure.

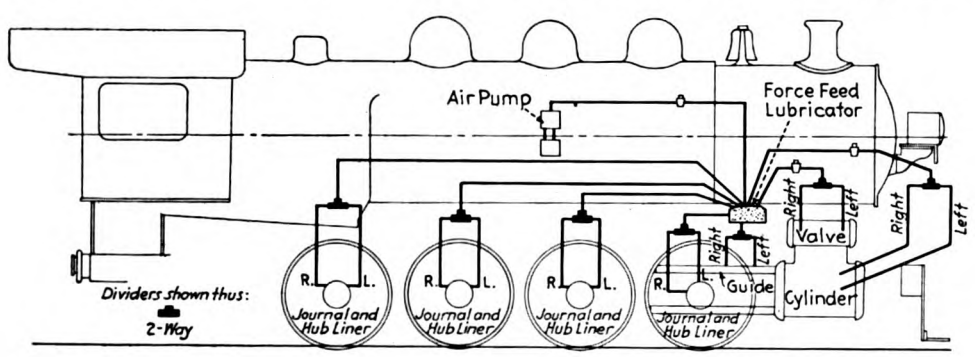
This same system of oil lubrication is also used on Pacific, 4-8-4 and other type locomotives of the Lehigh Valley.

Several years ago the Lehigh Valley adopted the use



The journals and hub liners on Engine No. 3137 were in excellent condition

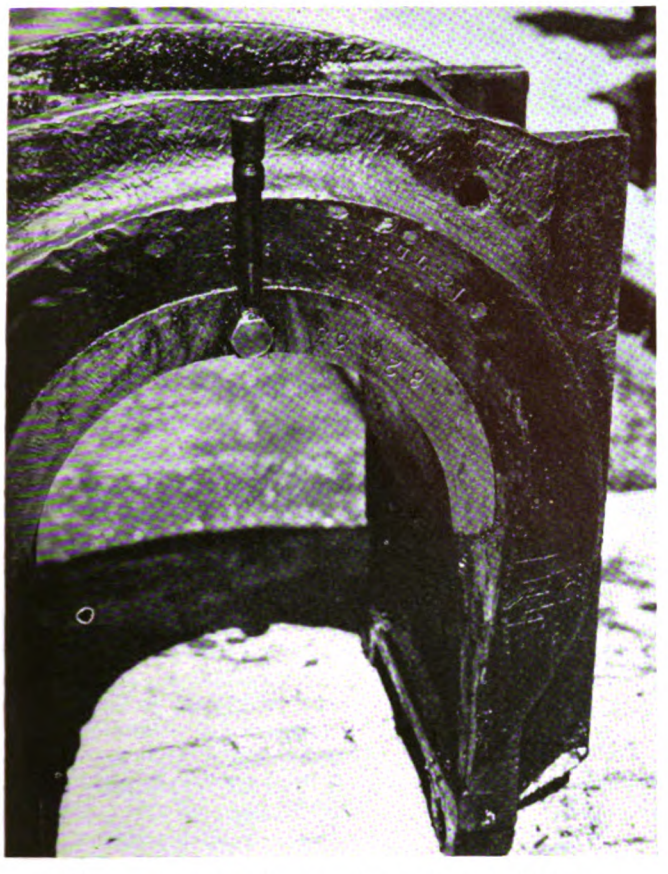
of floating hub liners, which were equipped for oil lubrication, the oil being distributed by use of these oil dividers. This was found to increase locomotive mileage between periods when wheels had to be removed for hub liner renewals. Prior to the adoption of oil lubrication, solid hub liners depending upon grease lubrication were employed. Due to track curvature and other



On an eight-wheel switcher oil is distributed to 21 locations from an eight-feed lubricator

physical characteristics it was necessary on Santa Fe type locomotives to remove wheels for hub liner renewals at approximately 4,000 miles. This mileage has now been increased to approximately 70,000.

On other classes of locomotives, before the adoption of oil-lubricated floating hub liners, the average mileage



Oil line connection to the crown brass of a main driving box

between shoppings was much less than under present conditions. Table I shows a comparison between the years 1929 and 1936.

The mechanical lubricators supplying oil to all parts of the locomotives have their feeds regulated on a test rack located in the Sayre system shops and are then sealed. After sealing, the setting of the feeds is seldom disturbed between shoppings of the locomotive.

When engine No. 3137 was given Class 3 repairs in

Table I—Comparison of Mileages Between Shoppings

No. of Locomotives	Road Class	1929	1936
	SWITCHING		
97	L-5, L-5½ & N-2	55,071	110,884
	FREIGHT		
70	N-4 and N-5	46,806	115,480
20	N-6	35,000	76,500
40	R-1	25,717	86,023
50	K-5	48,957	121,207
	PASSENGER		
9	K-2½	69,767	182,009
14	K-3	112,500	165,216
15	K-4	76,444	173,437
12	K-6	198,975	275,477

August, 1933, the driving journals were turned and rolled and the crown brasses were bored and rolled. The crown brasses were relieved to a distance of $\frac{5}{16}$ in. After four years of service, the journals, hub liners and crown brasses were found to be in excellent condi-

Table II—Quantity of Dope Eliminated per Journal

Loco. Type	Location of Dope	Waste, Lb.	Oil, Pts.	Total, Lb.
0-8-0	Drivers	2.2	8.8	11.0
2-8-2	Engine truck	1.7	6.8	8.5
	Drivers	2.0	8.0	10.0
	Trailer truck	3.0	12.0	15.0

tion and after such minor repair work as tire turning, brake and spring-rigging repairs was done on the locomotive, the parts were returned to service. An application for a one-year extension on flues was granted.

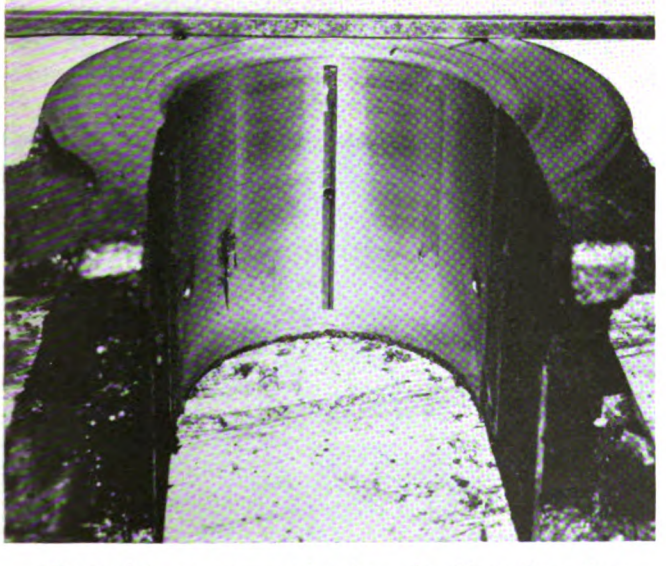
When the locomotive was unwheeled, measurements were taken of the wear on the various parts. The clearances between the toe of the crown brass and the journal just above the relief point were as follows:

Wheel No.	Right Side in., max.	Left Side in., max.
1	.003	.002
2	.002	.003
3	.003	.002
4	.003	.002

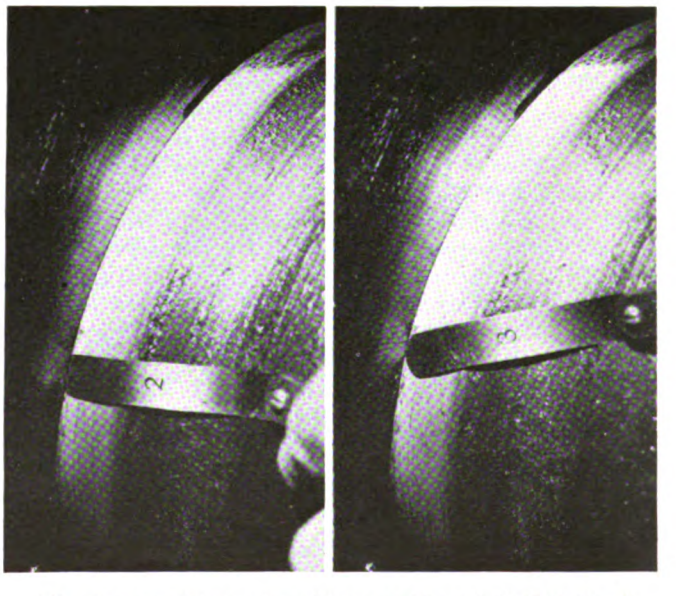
The wear on the floating hub liners was as follows:

Wheel No.	Max. in.
1	.187
2	.125
3	.125
4	.187

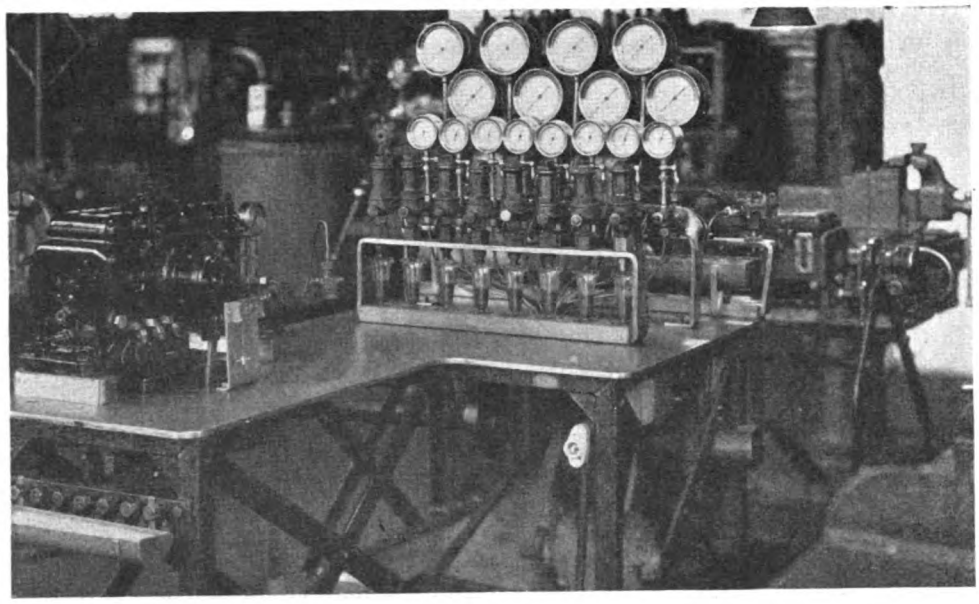
The wear on the rocker boxes was $\frac{3}{32}$ in. in the right side and $\frac{1}{32}$ in. in the left side. An idea of the nature



The condition of crown and hub faces after 49 months service



The clearance between toe of brass and journal at Right No. 2 was .002 in.



Test rack in the Sayre, Pa., system shop where all mechanical lubricators are tested and sealed before being placed in service

and the extent of the work that was done on this locomotive during 49 months of service, from August, 1933 to September, 1937, is indicated by the following items taken from the actual work reports:

1933
Sept. 28—Tighten R-1 wedge bolt.
Oct. 18—Set up R and L-3 wedges.
Nov. 28—Set up L-4—3 wedges.
Dec. 13—Set up R-1 wedge.
L-3 wedges.

1934
Jan. 23—Close in right crosshead guide.
Set up wedges both sides.
Key up right back main rod brasses.
Feb. 20—Oil pipe coupling loose leading to rocker boxes, right side.
Mar. 7—Close in left crossheads guides.
Apr. 25—Set up R-4 wedges.
June 5—Oil pipe to right rocker box loose.
June 18—Set up wedges.
Oct. 9—Oil pipe to R-1 driving box leaks.
Oct. 23—Right forward eccentric oil pipe burst.

1935
Mar. 15—Oil leak at right steam chest where oil plug screws in.
Mar. 26—Left back driver box oil feed not working.
Apr. 29—Oil hose disconnected right front main eccentric strap.
June 25—Oil pipe leaking at lubricator.
July 11—Tighten oil hose to left back eccentric strap.
Aug. 22—R-1 driving box not getting enough oil.

1936
July 2—Tighten union nut on oil pipe leading to left front crown brass.
Nov. 17—Tighten oil leak at force feed terminal at air portion.
Nov. 24—Tighten oil hose connection L-2 driving box.

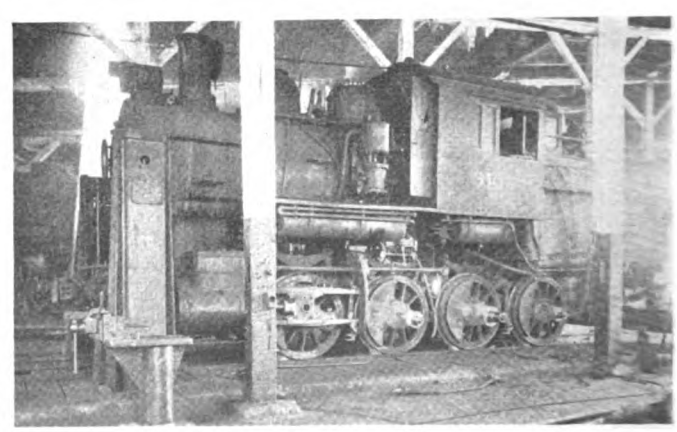
1937
June 8—Tighten oil pipe connection account leaking back of force-feed lubricator.
Aug. 26—Oil hose to left and right forward eccentric leaks.

These items represent all of the work that was performed on the locomotive pertaining to any parts oiled by this system of lubrication. The driving-box cellars on locomotive No. 3137 are equipped with secondary lubrication. Prior to the adoption of oil lubrication on the hub liners and journals as well as the valves, motion parts and crossheads, it was necessary to overhaul the motion work every eight months of active service. The main driving boxes required overhauling every six months, hub liners every six months, and the crossheads required relining on an average of once every six months. Experience with this lubrication system has indicated that it is possible to eliminate the swab holders on piston rods and valve stems as well as the oil cups on the guides, rocker boxes and eccentric straps. The mechanical lubricator is thoroughly cleaned out at monthly wash-out periods and at the same time the feeds are checked and tested and the oil lines blown out.

The employment of secondary lubrication makes the use of waste or "dope" unnecessary. Table II shows the quantity of "dope" per journal which is thereby eliminated.

Table III—Parts Lubricated on a Pacific Type Locomotive

Feed No.	Location	Dividers—No.	Dividers—Type	No. Flexible Connections	No. Points Lubricated
1	Trailer truck, journal and hub liner, right and left	1	2-way	3	4
2	Driving-box hub liners, right back	..	.....	1	2
3	Driving-box hub liners, right main	..	.....	1	2
4	Driving-box hub liners, right front	..	.....	1	2
5	Valve rod crosshead and engine truck center plate	2 1	2-way 3-way	..	7
6	Blank	..	.....	..	..
7	Blank	..	.....	..	..
8	Blank	..	.....	..	..
9	Frame shoes and wedges, No. 3 drivers	1	2-way	2	4
10	Frame shoes and wedges, No. 2 drivers	1	2-way	2	4
11	Frame shoes and wedges, No. 1 drivers	1	2-way	2	4
12	Blank	..	.....	..	..
13	Valve chamber, right side	..	.....	..	1
14	Cylinder, right side	..	.....	..	1
15	Stoker shaft bearing, rear	1	3-way	1	3
16	Stoker shaft, front end; radial buffer	1	4-way	1	4
17	Stoker engine	..	.....	..	1
18	Air-pump governor, drifting valve and generator governor	1	Atom.	..	3
19	Engine-truck journals and hub liners	1	4-way	4	4
20	Guides, top, sides and bottom, right and left	1 2	2-way 3-way	..	8
21	Driving box hub liners and hub, left back	..	.....	..	2
22	Driving-box hub liners and hub, left main	..	.....	..	2
23	Driving-box hub liners and hub, left front	..	.....	..	2
24	Link bearing, right and left	3	2-way	..	6
25	Valve chamber, left side	..	.....	..	1
26	Cylinder, left side	..	.....	..	1



Switcher No. 3137 ready for unwheeling at Perth Amboy, N. J.

Failures of

Locomotive Parts

By Fred H. Williams, M.Sc., F.R.S.A.

THERE are several causes for failures of locomotive axles in service. Stress-corrosion cracks, which develop into fatigue cracks, and fatigue cracks caused by a tool or other marks are so closely allied that it is extremely difficult to determine which may be primarily responsible for the failure. The writer is of the opinion that the life of a locomotive axle should be one million miles. This seems like a high figure, and yet it should be attainable. Main driving axles are removed from service when they make 300,000 miles. While some axles fail at a lower mileage, this has been fixed as a reasonable figure. If we could eliminate tool marks and stress-corrosion, the axles would be good for at least another 300,000 miles. This applies to both carbon steel and alloy steels, with slight exceptions.

Tool Marks a Matter of Controversy

The moment we mention tool marks we get into a controversy. Undoubtedly, however, they do cause failures and expensive ones, at that. We cannot afford to take chances.

Let us see what tool marks will do to a fatigue endurance test piece. Such a polished test piece may give 45,000 lb. endurance limit; that is the stress which will cause the test piece to fail at, say, ten million reversals. If, however, a slight tool mark is left on the test piece it will fail at 20,000 lb. stress, and probably at a much smaller number of reversals. In other words, the life of the test piece is cut in half by a fine tool mark. The same thing applies to the axle from which the test piece is taken. If, in addition to the tool marks, conditions are complicated by stress-corrosion, the test piece will, of course, fail at a still lower stress than where this combination does not exist.

Axles have failed after only 80,000 miles of service from stress-corrosion which has developed into fatigue cracks, or from tool marks which have done the same thing. Unfortunately the tool marks so affect the surface that, given an opportunity, corrosion will start much more rapidly than on a smooth surface. The tool marks also tend to concentrate the stresses.

Typical Fractures

The fracture of a main driving axle, which is typical of many such failures, is shown in Fig. 1. This failure was caused by a number of fatigue cracks starting on the surface of the wheel fit. The fatigue crack which caused the fracture started about one-half inch from the hub face and, as will be seen by the texture of the broken metal, extended very nearly across the section before the axle failed completely. The fatigue crack is represented by the more closely grained structure, while the final fracture is indicated by the coarser section at the lower left-hand side.

It will be noted that two of the fatigue cracks started to the left of the keyway and quite near each other. They were, however, at different planes and a close examination of the wheel fit surface indicated that they originated in two parallel tool marks (Fig. 3). The fracture also indicates that another fatigue crack started about one-half inch to the right of the keyway, as is indicated by the rings of progression of the fatigue crack. These three cracks continued to grow progressively and eventually united and finally developed to a point where they caused the failure of the axle. The steel was satisfactory, since it did not give way until the fatigue crack had extended to about 90 per cent of the area of the section. Incidentally, this indicates that the material was an alloy steel (nickel, in this case), since plain carbon steel would not ordinarily stand up so well under such conditions.

An enlargement of the fatigue cracks to the left of the keyway is shown in Fig. 2, the dark mark between them being caused by shadow, due to the fact that the two cracks were on different levels, starting from adjacent tool marks, somewhat less than 1/16 in. apart. An enlarged view of the surface of the wheel fit is shown in Fig. 3, clearly indicating the difference between these two planes. The tool marks which caused the fracture stand out quite clearly.

It may be contended that such machining is adequate since the surface of the axle is torn when the wheel center is pressed on. It must be remembered, however, that the torn surface lengthwise, is not as harmful as the circumferential tool marks. Some corrosion is apparent on the surface of the axle and doubtless this had its part in assisting in the development of the fatigue cracks. The axle in question failed at less than 300,000 miles.

Stress-Corrosion Cracks

Why does a tool mark influence the steel surface to corrosion and thus start the axle on its way to failure? In my opinion, because the tool tears the surface, and in so doing changes the normal potential between the grains; this tends to develop an electric current flow between these grains, and with the least moisture present, electrolysis results and corrosion starts. The smoother the surface and the less disturbance of the grain structure, the less possibility there is of corrosion, which means rust and pits, then stress-corrosion cracks, then fatigue cracks, and finally the complete failure of the axle or any other part of the locomotive which may be subjected to reverse stresses.

A mild heat treatment after the machining would, no doubt, remove the surface strains, but care must be taken to have the proper temperature applied to the part under treatment. Not only is it necessary to use care in machining the finishing cut, but the roughing cut should be free from excessive tears. Hogging the material off is dangerous, making it almost impossible to remove the effects by a finishing cut. I have seen a 12-in. axle so machined that the effect of the rough tool marks could be noted after the finishing cut had been made.

Another type of failure caused by tool marks and stress-corrosion is shown in Fig. 4. Looking at the top of the photograph it is apparent that the fatigue crack started from several nuclei, these several cracks uniting into the larger fatigue crack. As indicated in previous articles, these fatigue cracks start where special stresses concentrate on the surface in lines or spots, such as tool marks, tears in the metal, corrosion pits, or even inclusions in the steel. Conditions of service and the

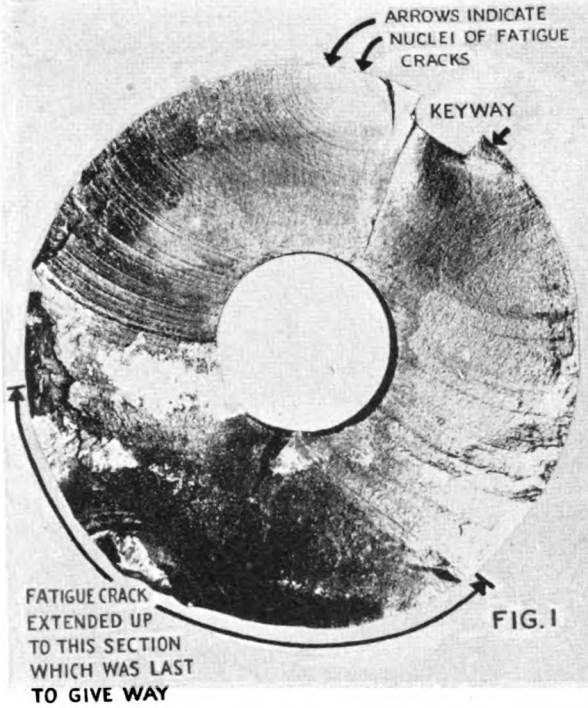


FIG. 1

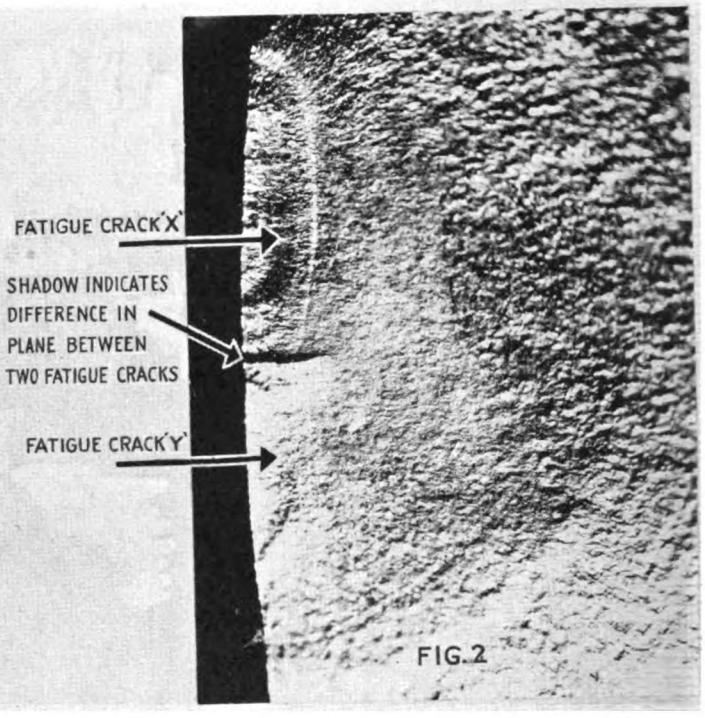


FIG. 2

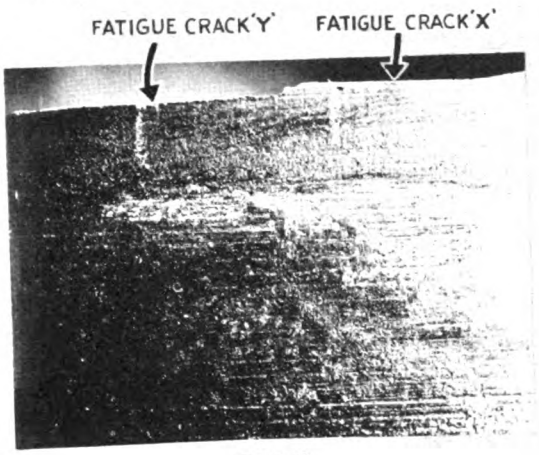


FIG. 3

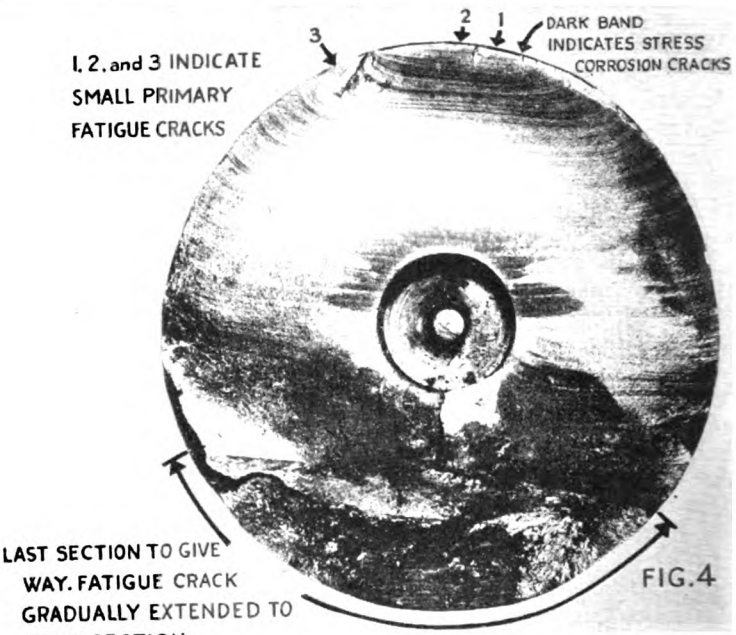


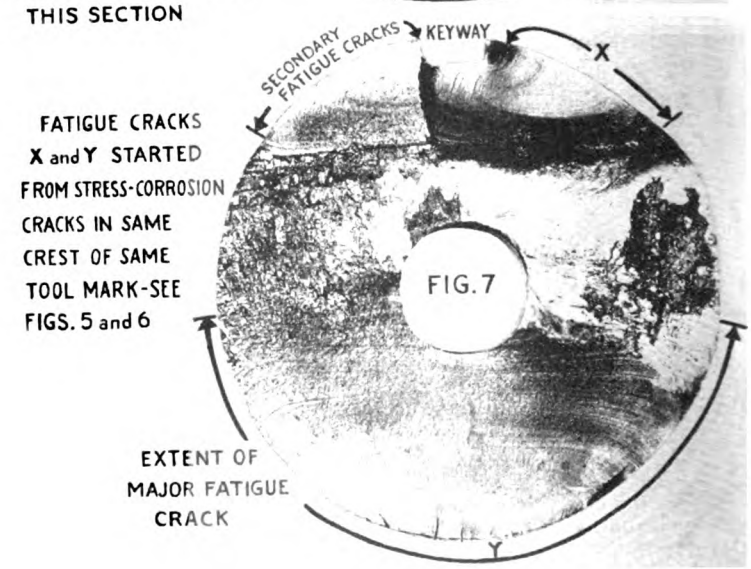
FIG. 4



FIG. 5
FRACTURE STARTED ALONG LINE (A-B)



Y
FIG. 6



steel used naturally enter into the problem. This does not mean that you can secure steel that will resist the starting of fatigue cracks, but some steels can do so better than others. It will be noted from the finer texture of the break that the fatigue crack gradually extended over nearly 75 per cent of the area before the final fracture occurred. This would indicate that a good steel was used and that its heat treatment was satisfactory.

The finish on the wheel seat of another axle which failed at less than 300,000 miles, is shown in Figs. 5 and 6. Here we have a wide finishing cut and the surface in general seems to be smooth and satisfactory; indeed, it is the type that is recommended by some engineers and shop authorities. The fatigue crack in Fig. 4 started in the hollows of well defined cuts, but that for the axle shown in Figs. 5 and 6 originated not in the hollows of the cut, but at the crests.

Fig. 1—Cross-section of a main driving wheel axle which failed in service. Fig. 2—Enlargement of the section to the left of the keyway in Fig. 1. The shadow indicates difference in plane between the two fatigue cracks. Fig. 3—Enlarged view of the surface of the wheel fit of the axle, indicating clearly the two tool marks from which the fatigue cracks shown in Figs. 1 and 2 originated. Fig. 4—Cross-section of the main driving wheel axle which failed in service. Here corrosion, indicated by the dark band, combined with tool marks to start fatigue cracks. The break occurred in the wheel fit, about ½ in. from the hub face. Fig. 5—Side view of break which occurred in the wheel fit of a main driving axle. The crack started in the crest of the tool mark made by the finishing tool. Corrosion is indicated by the rubbed surface on the crest of the cut. Fig. 6—View of the other side of the break shown in Fig. 5. Fig. 7—Cross-section of the break shown in Figs. 5 and 6. The narrow black band at the bottom (indicating corrosion) was 1/16 in. deep and about 4½ in. long.

A cross-section of the fracture illustrated in Figs. 5 and 6 is shown in Fig. 7, and it will be noted that there are at least three fatigue cracks, one on either side of the keyway, and one on the opposite side of the section. Note the thin rim of dark at the bottom of the photograph and the frilled structure of the fracture before the smaller cracks unite into the larger fatigue crack. The narrow dark band which extends for about five inches in length of the circumference is a stress-corrosion crack, which started at the crest of the tool mark. Here, then, we have a combination of a rough surface and stress-corrosion, which is quite as destructive as the sharp machine tool cut, where the fatigue crack starts in the hollow.

An enlargement of a photograph of the machined surface of the wheel fit on this axle is shown in Fig. 8 and throws further light on the cause of the fracture. The finish here is so rough that it is difficult to pick out the crests and the hollows of the cuts. The latter are indicated by their rougher bands and close examination will enable one to pick out the crests in a close, partially cold worked surface. The smooth surface to the left is the journal which is smooth and polished.

Another type of failure on what many people would call a good finish for a wheel fit, is illustrated in Fig. 9, which shows the cross-section of a fracture of a main driving axle. It somewhat resembles the other fractures, except that fatigue cracks extended over nearly the full surface, or through almost the entire section before failure. This is a heat treated (quenched and drawn) carbon steel axle. The extent of the fatigue crack before the final fracture indicates good steel.

The main fatigue crack seems to be directly opposite the keyway and there are also two small fatigue cracks at the edge of the keyway. Close examination indicated,

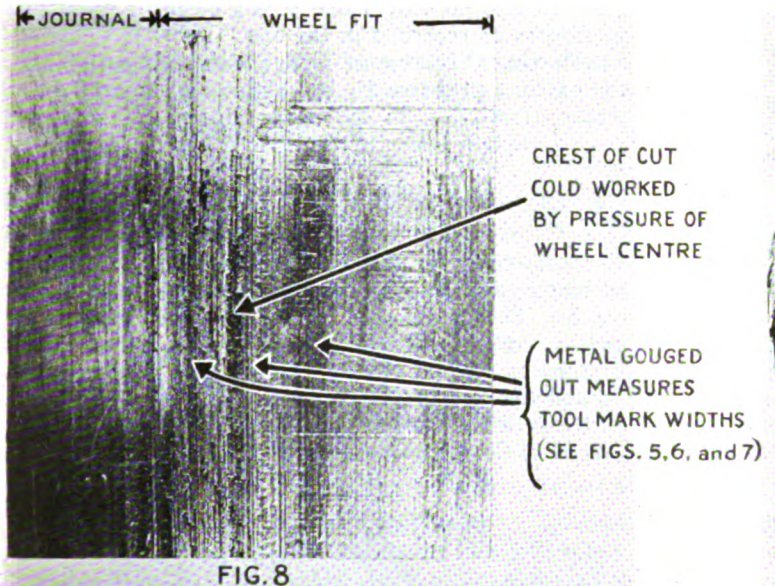


FIG. 8

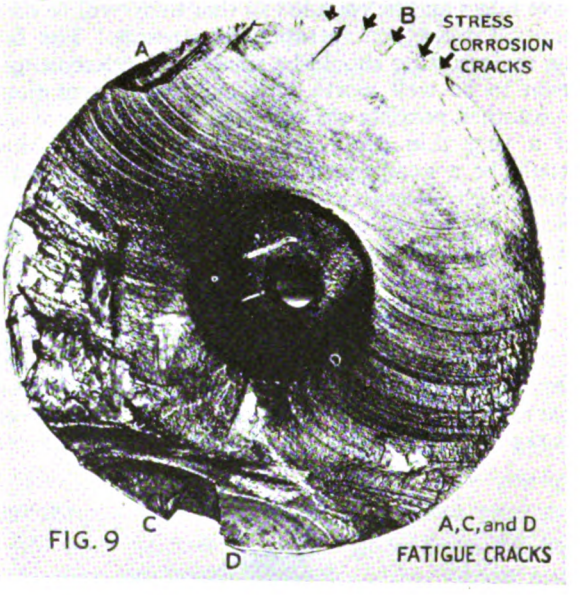


FIG. 9

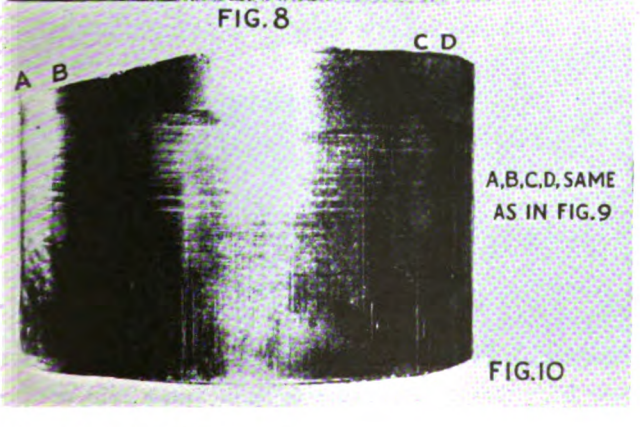


FIG. 10

Fig. 8—Enlarged photograph of what is known as a smooth surface on the wheel fit of an axle. For other views of the same axle see Figs. 5, 6 and 7. Fig. 9—Cross-section of fractured axle which failed because of fatigue crack starting ⅝ in. inside the wheel fit. A, C and D indicate separate fatigue cracks. B was due to a combination of the stress-corrosion cracks indicated by the arrows. Fig. 10—Finish of wheel fit of the main driving axle shown in Fig. 9.

however, that the fatigue cracks started at the wheel fit and a short distance from the edges of the keyway. Judging from the frills, we may conclude that the major fatigue crack was formed by a number of small cracks, indicating that stress-corrosion undoubtedly had considerable to do with the failure. The finish on this axle is shown in Fig. 10, indicating a broad finishing cut.

The Remedies

Even 12-in. axles have small surface stresses. Some tests, for instance, have shown that reversible stresses of about 3,000 lb. will cause a 12-in. axle to fail. The action of the movement of the wheel center on the axle starts corrosion, so that the stresses and corrosion are combined, and the cracks start without the heavy stresses which many people believe necessary to cause the failure of an axle of this size.

How can we remove these stresses? The use of cast-iron wheel centers would help a great deal if someone could develop such a wheel. The damping effects of cast iron relieve the stresses that attack the axle surfaces. As an example, passenger-car axles made of steel of lower physical properties than locomotive axles do not fail in the wheel fit where cast-iron wheel centers are used. The fact that we can now secure 60,000 lb. to 65,000 lb. tensile strength with the latest alloy cast irons would indicate possibilities in this direction.

Then, too, the practice of undercutting could be followed, as was advocated in previous articles which I have written for the *Railway Mechanical Engineer* on the failures of piston rods and crank pins. Undercutting will eliminate the causes of rust as well as the greater portion of the stresses that combine with corrosion and develop the stress-corrosion cracks. The undercutting should be .005 in. deep and from ¼ in. to ½ in. wide, about ½ in. inside the wheel center. The edges should have fillets and be rounded so that there will be no opportunity for the concentration of stresses. The finish of the undercutting should be smooth. Undercutting would seem to be well worth trial and experimentation.

Another possible remedy would be the metal spraying of a very thin depth, say .001 to .002 in. Aluminum would be a good metal to use and it has been tried by some with success and by others with failure, so this means that there is a good and a bad way to apply it. Having proved satisfactory to some there is no reason why it should not be well worth trying.

Why wait for failure? Why not use some of the methods which have given good results in similar installations? As indicated, these might include undercutting, metal spraying, smoother finishes and freedom from tears in the metal. Deep, or comparatively deep, tool marks should be eliminated. Machined surfaces such as shown in this article should be avoided, unless undercutting or metal spraying is used, and then a slight leeway in the smoothness of the finish can be allowed.

Reading Installs Streamline Train

(*Continued from page 4*)

streamlined with stainless and painted steel, the latter conforming to the lines of the coaches. An appearance of continuity of the sides of the coaches and tender has been effected by extending the sides of the latter beyond the tender end sill to enclose the rounded observation end of the forward car. A horizontal extension from the top of the tank produces a similar effect in the roof lines by enclosing the hooded portion over the end of the car. Louvers in the front of the locomotive shrouding near the top admit air which flows out of a port in the top of the shrouding just back of the stack to function as a smoke lifter. The estimated weight of the engine and tender is approximately 460,000 lb.

The Locomotive Front End

(*Continued from page 11*)

this discussion in all calculations involving V_2 and H_2.

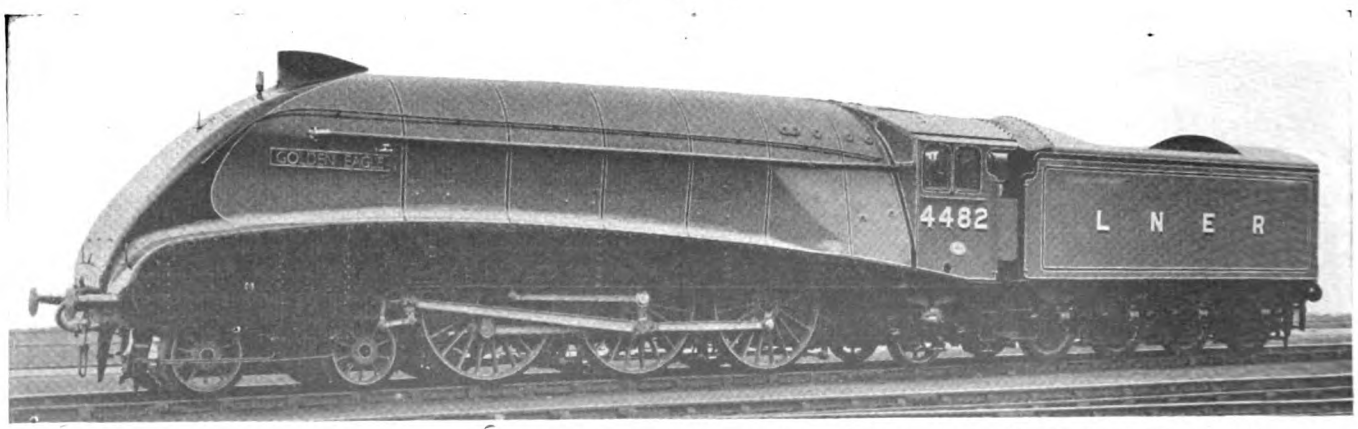
For calculating the consecutive values of M_t, shown in Fig. 4, tables were constructed similar to Table V, which applies to locomotive *A*; only sufficient values of M_t were calculated to establish the curve. The temperature t_1 given in column 4 of Table V is a mean of the actual temperatures as recorded in the test.

As affecting the value of $\triangle H$, a misreading of 0.5 lb. in the exhaust pressure P_1 has about the same effect as an error of 40 deg. in the temperature t_1. This fact serves to explain some of the discrepancies in the test record.

The constancy of the relation between $\triangle P$ and $\sqrt{\triangle H/V_2}$ is shown by Fig. 15, which represents all of the tests cited for the eight locomotives. The curve is calculated on the basis of the temperature range shown above it. The actual test results are indicated by appropriate symbols. It will be seen that the curve closely approximates the test results, even though in some cases the actual temperature is 75 deg. F. above or below the mean temperature used in calculating the curve.

Part II of this article will appear in a subsequent issue.

* * *



The "Golden Eagle," the first of a new series of streamline express passenger locomotives on the London & North Eastern Railway

EDITORIALS

It Is To Smile!

According to the Railway Gazette of London, England, a controversy seems to be raging in the correspondence columns of a daily newspaper of that country, over the use of the words chimney or funnel "for the smoke uptake of a locomotive." The Railway Gazette points out that the word chimney has been used from the earliest days of the locomotive, dating back to 1804, when Richard Trevithick referred to the chimney of his "tramwaggon." On the other hand, the term locomotive chimney seems weak and effeminate to an American. It is never used in this country, even by non-railroaders. Smokestack seems far more appropriate when associated with our rugged and powerful locomotives, and then too, imagine how the railroad or locomotive "fan" would react to the term employed by our British cousins!

Tolerance

This is an unusual type of comment for a publication such as the *Railway Mechanical Engineer*. It is inspired by expressions received through the mail and otherwise, suggesting that we have a responsibility to discharge beyond that of discussing the technical problems in which we are primarily interested. In a way, it reflects an awakening interest on the part of individuals in a more intelligent participation in civic and political affairs.

The success of a democracy—a rule *of* the people, *for* the people, and *by* the people—can be gaged by the degree to which all of the members of the community work together for the common good. America has offered a unique opportunity for experimentation with representative democracy on a large scale. The United States, in particular, with its great natural resources and vast area, comparatively thinly populated, has thus far been unusually successful in its government and in improving the economic status of its citizens.

Made up as it is, however, of people coming from all parts of the world in large numbers over a long period, we have an unusual mixture of races, nationalities and religious creeds and beliefs within our borders. Conditions are still further complicated by the marked differences in climatic and economic conditions in various parts of the country. There seems to be a particularly strong tendency at the present time for the population of the different communities to divide into minority groups of various sorts and to use high pressure, press agenting methods in promoting their activities, which too frequently are of a selfish nature and sometimes with little regard for the general welfare. This intensifies class differences and engenders class strife.

Politicians, in campaigning, frequently play up to this in an impassioned manner—a rather disturbing factor to those who are sincerely interested in developing better understandings and higher ethical standards. Elective officers who would prefer to develop statesmanlike policies, often find themselves hampered by narrow sectionalism, and, it is to be feared, too frequently act under political pressure in the interests of a small minority group, rather than for those of the country or community at large.

The exceedingly trying period through which we are passing is such that each one of us must studiously strive to exercise a broad and intelligent viewpoint, else our democracy may go the way of others which have been replaced by dictatorships because of lack of interest and action on the part of intelligent citizens, coupled with abuses and high-handed methods on the part of those in political power.

New Shop Equipment Will Pay For Itself

A primary need in railroad shop equipment today is that of the replacement of a substantial proportion of the machine-tool inventory which, because of obsolescence due to age, is no longer able to meet the demand for volume production or accuracy of finish. More than 70 per cent of the machines in the average railroad shop are over 20 years old. When one considers the advances which have been made in the last 10 years alone in the art of metal cutting, almost anyone will concede that a 20-year-old machine is certainly to be classed as obsolete.

It is not necessary to indulge in any complicated mathematical calculations in order to appraise the cost of using obsolete machine tools. Let's take some actual figures in order to build an hypothetical case, apply some conservative estimates and compare the result with authentic service data. The result is sure to be surprising. In a certain locomotive repair shop there are 220 machine-tool units in the machine department. Of these, 67 per cent, or 150 machines, are over 20

years old. Assuming that the 150 machines comprising the group over 20 years of age are used 40 hours a week each, the wages paid to the machinists operating them amount to over $250,000, in a year. This total, incidentally, is $15,000 greater than before the recent increase in wages to shopmen. When that wage increase was granted it was necessary to curtail the hours worked by repair shops and consequently curtail the restoration of locomotive miles to road service. Experience indicates that the expense of machine-shop labor on these 150 obsolete machines could be reduced at least $65,000 a year by replacing them with modern units at an estimated capital outlay of from $475,000 to $500,000. This estimate of saving does not include reductions in the cost of machine-tool maintenance, reduced electric power consumption or economies resulting from a higher grade of workmanship.

In order that the reader will not be inclined to consider the above hypothetical case too much in the light of guesswork, a glance at facts may be worthwhile. A study recently made of 90 representative locomotive machining operations now being performed on machines over 20 years of age indicated that the time required could be reduced by an average of 42 per cent if the work were to be done on modern machines with modern tooling equipment. In the light of this figure, the estimate of $65,000 seems conservative enough.

Numerous installations made in the past three years indicate that one modern machine has enough greater productive capacity that it can take the place of from 1.35 to 2.50 machines of the 20- to 30-year-old type. By applying the minimum figure alone to the hypothetical shop, one arrives at the conclusion that 150 old machines could be replaced by 112 new ones. At 40 hours a week the labor cost of operating the 38 displaced machines amounts to over $65,000 a year, not to mention the saving of from $8,000 to $11,000 annually in repair costs due to their advanced age, and an additional estimated saving of about $3,700 a year in electric power.

Typical of the results which have been obtained as a result of machinery replacement programs is that of an eastern railroad which in 1935, planned a program for the retirement of 50 obsolete tools having an average age of 33 years and replacing them with 37 modern tools at a cost $227,000. It was estimated that, by operating the new machines 16 hours a day, 26 days a month, a saving of 26 per cent on the investment could be obtained. This would amount to $59,020 a year or $4,918 a month. The program was approved and the 37 machines were purchased and placed in operation by March, 1936. Due to business conditions the first full year's operation resulted in using this new equipment only 43 per cent of the planned two-shift operation. In spite of this, the savings effected at the end of 20 months' operation amounted to $86,478 or a total of 38 per cent on the investment. The monthly average was $4,324.

Another road recently retired 13 old machines in one group and replaced them with five new machines at a saving of 65 per cent in the cost of the parts produced in that department.

There are any number of cases where individual units of new shop equipment have paid for themselves in from one to two and one-half years but any lengthy presentation of such cases would add but little to the well-known fact that (1) new shop equipment is badly needed by the railroads; (2) that there should be little excuse for not buying it when it has demonstrated its ability to pay for itself, and (3) if the roads do not make plans to modernize facilities in the face of increasing costs they will inevitably find themselves in a position of being forced to choose between higher repair costs or deferred maintenance.

Welding Saves

One of the outstanding facts about shop-equipment orders in the railway field for 1937 is that three times as many electric-welding sets were purchased as compared with the purchases in 1929. This is indicative of the increased utilization of welding in car construction and equipment maintenance.

Welding is one of the two main factors in reducing the tare weight of freight and passenger cars, the other factor being the utilization of high-tensile alloy steels or strong aluminum alloys. In 1931, the Pullman Standard Car Manufacturing Company, built five welded 70-ton hopper cars of plain carbon steel which had a light weight of 45,900 lb.; this weight, compared with 50,200 lb. for the lightest riveted design of 70-ton hopper, represented a weight saving of 4,300 lb. through the use of welded fabrication alone.

In 1935, a number of welded cars were built in which high-tensile lightweight alloy steels were used extensively. All of these cars showed substantial tare-weight reductions as compared with riveted cars of plain carbon steel construction. One of these cars, a 50-ton 40-ft. box car built by Pullman, was fabricated by welding and showed one of the greatest weight savthetical shop, one arrives at the conclusion that 150 mately 10,000 lb. less than the 1932 A.A.R. standard 50-ton 40-ft. box car of plain carbon steel and riveted construction. It is interesting to note that this same weight reduction of 10,000 lb. has been effected in a 50-ton 40-ft. box car recently built by this same company to inside dimensions similar to those of the A.A.R. 1937 specifications, in which the tare weight and cubic capacity were increased to 45,300 lb. and 3,711 cu. ft., respectively, from 44,100 lb. and 3,311 cu. ft., respectively, for the A.A.R. 1932 design.

One of the noteworthy reductions in the weight of passenger cars is that of all-welded coaches built in the Milwaukee shops of the C.M.St.P.&P. This road built

52 all-welded steel coaches in 1934, employing plain carbon steel, which weighed 96,000 lb., as compared to 146,000 lb. for cars of conventional riveted construction using plain carbon steel. The weight reduction of 50,000 lb. was effected by a design adapted specifically for fabrication by welding. In 1936, when the C.M. St.P.&P. built nine train units for the Hiawatha, which were of the same conventional structural design as the cars built in 1934, a further weight reduction of approximately 10,000 lb. was effected by using Cor-Ten steel.

Welding is also being used more and more extensively in the railroad shops as a means for reducing maintenance expense of motive power and rolling stock. With the advent of improved electric-welding sets and designs of gas-welding equipment, as well as welding rods of higher physical properties and improvements in welding technique, the railroads have been able to show great savings in shop costs. For example, in 1937, one midwestern road showed a saving of $360,000 due directly to the use of electric welding.

Structural Defects In Freight Cars

Entirely aside from the effects of more or less unavoidable deferred maintenance, freight equipment now in use on American railroads is giving less efficient and satisfactory service than desirable, owing to certain features of design or construction which should be corrected wherever possible in present equipment and guarded against in all new designs. Responsible mechanical department officers welcome constructive suggestions for the improvement of equipment, from whatever source received, and consequently they are studying with interest a series of comments and suggestions, recently developed by the A.A.R. Freight Claims Division, as a result of an intensive study of specific car defects responsible for damage to various classes of commodities during shipment by rail.

As regards box car roofs, the report states that low carlines, some of which extend a foot or more below the inside surface of the roof, cause damage to furniture and other classes of freight. A common source of trouble is the shrinkage of siding resulting in comparatively large openings between siding boards with consequent admission of rain and dirt. In the case of single-sheathed cars, experience is said to indicate that the siding should be at least 1½ in. thick and not 1 in. as is now sometimes the case. It is suggested that all corrugated steel ends should be lined to prevent damage to freight, both the ends and the lining being constructed so as to permit moisture to drip and escape from behind the lining.

In connection with doors and doorways, the failure of car doors to fit flush against the decking all to frequently permits the entrance of dust and cinders. In some instances door strips are not flush with the lining. It is also important to have door posts and strips properly bevelled on both sides. One road has provided slots in steel door posts to permit the application of door protection, and apparently this practice should be made more general. Steel threshold plates on box cars having a provision for the safe application of loading bridges are a decided advantage and some roads have provided open slots for this purpose. The suggestion is advanced that many varieties of door and seal locks do not serve their purpose efficiently, and railway mechanical departments can help by endeavoring to eliminate the great variety of patent locks which are said to contribute to freight loss rather than preventing it.

In refrigerator cars, it is suggested that the roof and ceiling construction be designed so as positively to prevent cinders or insulation dust from working through and falling on the lading. Some refrigerator-car hatch covers are held open with a pin arrangement, these pins working out under the motion of the train and permitting the vents to close, thus creating a defective record. Refrigerator-car floors which extend under the bulkhead, with drip pans of insufficient width, permit melted ice to run in on the car floor. When floor-rack slats are held in position by screws, these frequently work out and cause damage to sacked goods and corrugated containers. Apparently slats should be bolted securely and placed longitudinal instead of crosswise. Obviously floor-rack fasteners in the side walls should be countersunk and all floor-rack slats bevelled.

In stock cars, low carlines present a hazard to horses by head injuries and it is felt that no carlines should extend below the inside surface of the roof, the necessary clearance for horses or mules being 8 ft. 7 in. The rearrangement of side boards is suggested to avoid injury to the hocks of horses and mules under present-day train speeds and vibration. Possibly at least one opening between the slats should be closed at a height of 18 in. to 22 in. Many stock cars are said to lack necessary means for applying partitions and the suggestion is advanced that consideration be given to the Con-Bur Brace Assembly developed by the A.A.R. Freight Container Bureau.

Another common complaint in stock cars is that bull-bar brackets are not flush with the door posts. Some types of doors with perpendicular slats in the metal frame may cause injury to animals crowding out of the car. This construction should presumably be altered to make the unloading of the car equally safe whether the door is fully or only partially open. Steel strips down the center of the floor, each 4½ in. wide and about 2 ft. apart, frequently cause animals to slip. Warped floors also are a potential hazard.

Due consideration of suggestions such as these by mechanical-department officers responsible for car conditions will doubtless be accompanied by appropriate action and do much to improve the standard of serviceability of freight equipment.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

The Keynote

The passing of the old days of a one-man shop is welcomed by everyone, but in the modern shop it is found no longer possible to be a successful executive by merely being a good mechanic. Co-operation is the keynote, and it is a fortunate superintendent who is able to get it.

Roundhouse Economies

How well all supervisors appreciate the suggestions made by Walt Wyre in his story in your November issue! More modern machinery is needed at division points; it is a fact that all foremen are racking their brains in the effort to secure time-saving machines.

A Big Customer

How many of your readers keep themselves informed on the great national importance of the vast network of railroads in this country, and by which we are employed? From whatever point of view we approach this problem, we cannot but be impressed. For instance, materials and supplies in 1936 cost the railroads $803,000,000. About 16 per cent of the total timber cut from our forests was purchased by the railroads; also about 23 per cent of the bituminous coal mined, and about 19 per cent of the fuel oil. The railroads also took about 17 per cent of the total iron and steel output of the United States. Truly, they represent one of the largest customers of the basic industries of our country.

Move Fast and Get Out of the Way

Has it ever occurred to you that the modern locomotive has saved the railroads large sums of money by postponing the requirement for second and third tracks and reducing the number of passing tracks. A train that gets over the road will leave clear tracks for other trains.

A Little Coaching Needed

You had another article in the November issue which is very good; that is, the one about Diesel-engine repairs on the Canadian National. I have noticed many times that men become intolerant of the supervision of the general officers, because it delays their work for the moment. The forms and reports used in this class of work show how valuable information can be obtained by requiring their use.

Some Challenging Questions

Several types of disk wheels have been developed. Have the anticipated improvements been realized—in greater strength, retaining rotundity, better balance and reduction of dynamic augment?

With high piston speeds never before experienced, together with high temperatures, the cylinder packing becomes a problem.

How are different roads going to meet the requirement of providing seating for head brakemen?

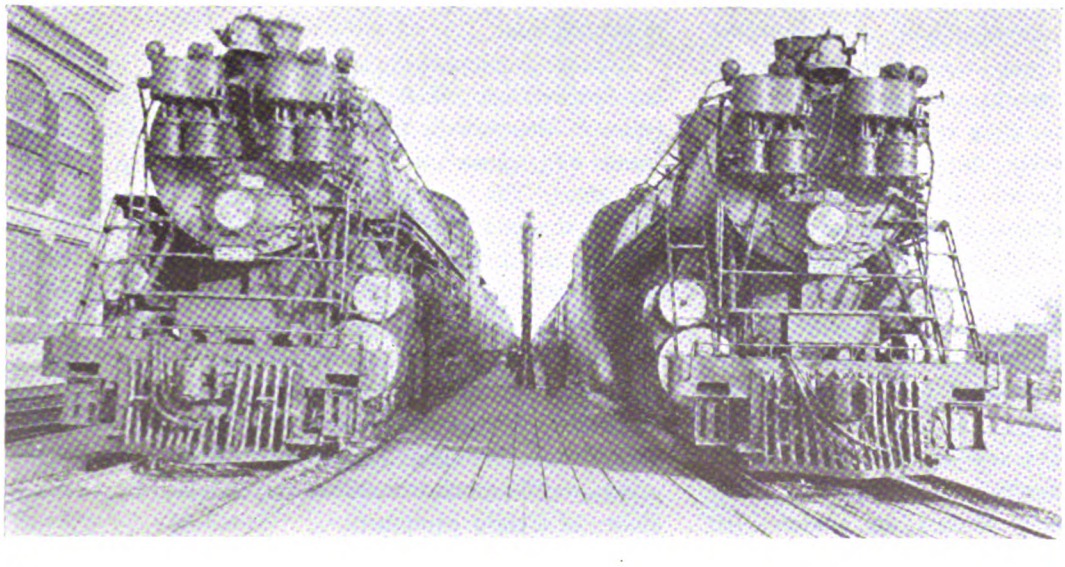
It appears an epidemic is being experienced with laminated boiler sheets, which no one as yet seems able to explain.

Considerable trouble is experienced with broken tires and heat checks and cracks in them; also developments are under way for improvements in brake shoes.

Considerable thought is being given to trucks that will contribute to the better riding of trains at high speed.

There seems to be a lack of authentic information as to the cost of operation and availability of Diesel equipment in main-line service.

Photo by Thomas T. Taber



An unusual coincidence—"The Empire Builder" and "The Fast Mail" of the Great Northern at Fargo, N. D., at the same time

THE READER'S PAGE

Failures in Crosshead and Piston-Rod Key Slots

To the Editor:

In many cases poor workmanship and improper machining methods on crossheads and piston rods for finishing key slots have been the cause of piston-rod failures. Often poor drilling is the main factor in causing failure. Again, piston rods fail because of the excessive use of the so-called engineer's soft hammer. The piston rods cannot be kept snug in the crosshead because they lack supporting metal at the small end when the slot is too near that end. Consequently, the incessant reversal of stresses and severe punishment with the hammer developed cracks at the small end that often leads to failure and rejection. The fact that such piston rods are placed in service indicates lack of proper understanding of the needs in exact locomotive maintenance, inadequate inspection, or a lack of funds to provide proper tools, such as milling machines and necessary jigs and fixtures.

Drilling of piston rods and crossheads on the average drill press shows that the shop lacks proper facilities for the work. No up-to-date master mechanic or shop superintendent would permit a machinist to drill a piston rod half way through, turn over, reset and finish the hole from the opposite side. The fact that the work was so finished shows most convincingly that the slots in crossheads were improperly located due to a lack of equipment. The big radial press is a poor makeshift for drilling crosshead-key slots.

Herewith are drawings that provide a method for machining key slots in piston rods and crosshead which, when properly applied, will eliminate failure of these parts at the key slot.

Figs. 1 and 2 show a crosshead mounted on a milling machine fixture. The first operation is to drill two holes in the proper relation to the finished key slot. The hole *A* is drilled ⅛ in. smaller than size, is enlarged by a reamer drill and then finished with a reamer. Hole *B* is drilled next and reamed. The piston rod, which is clamped in a vise, is now pushed to one end of the table as shown in Fig. 3. The spiral mill is then put through one of the holes in the crosshead and the slot is finished between the two reamed holes *A* and *B*. The face of *A* is relieved for the proper clearance. The jig is now set over at one end and face *B* is finished at the proper angle as shown in Fig. 3.

The crosshead is then taken off the milling machine, and the piston rod is pushed forward into position for milling. The mill is placed in one of the holes *A* or *B*, shown in Fig. 3, and the slot is milled. The face of hole B is relieved for the key clearance *C*.

Foreman.

Thermal Checks in Engine-Truck Wheels Eliminated

To the Editor:

On page 410 in the September, 1937, issue of the *Railway Mechanical Engineer,* your correspondent inquiries about the causes of thermal checks in the hubs of engine-truck wheels, and how can such checks be eliminated. He also wishes to know if the difficulty is peculiar to his railroad. Herewith are details of similar trouble noted on a mountain division of a northwestern road. The roadway was composed largely of grades and curves with short tangents in between. New locomotives after 21 days' service were returned to the main back shop, lifted from drivers, stripped of boxes, the hubs of drivers and truck wheels were faced for bronze liners, and crown brasses were refitted.

This costly and drastic procedure eliminated hot boxes and thermal checking. It was noted that the heating of driving-wheel and engine-truck boxes was caused by the heavy frictional contact between the hub and box and the lack of a steady flow of lubricant to the journals. The closure of crown brasses due to heating accentuated the trouble. The heavy side impact of the heated boxes against the heated hub faces caused the development and extension of cracks from the zones of thermal checking. However, it was noted that progressive cracking in and adjacent to zones of minor thermal checking was not as liable to produce wheel failure if the wheels had been relieved of internal stresses by heat treatment.

The necessity for heat treatment of car and engine-truck wheels arises from two principal sources: (1) The total relief of internal manufacturing stresses so that the metal of the finished wheel possesses its full potential strength, and (2) a modification of the structural chilled tread which will increase the resistance to impact failures and temperature gradients resulting from heavy brake-shoe applications and, in the case of engine-truck wheels, the lessening of thermal checking due to the severe side impact of the hub and truck box.

Frank Rattek

Three positions for milling the key slot in crossheads and piston rods

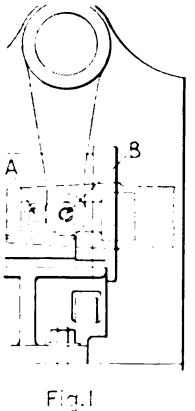


Fig. 1

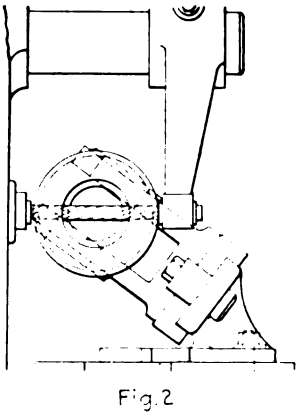


Fig. 2

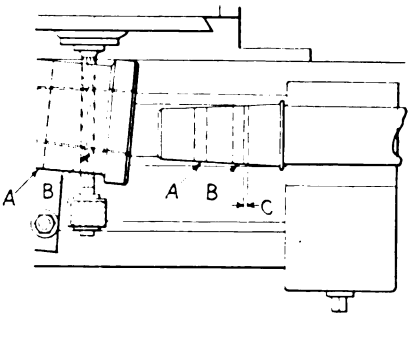
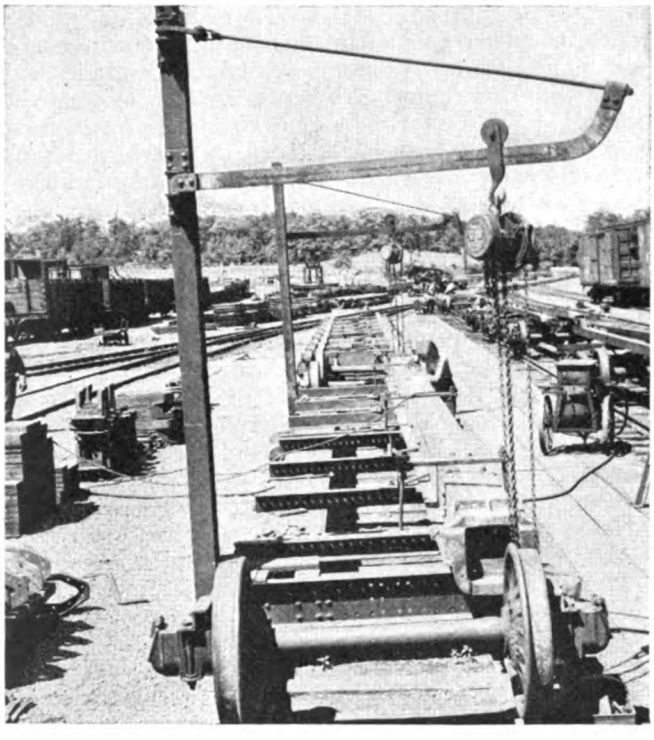


Fig. 3

With the Car Foremen and Inspectors

Car-Building Practice At the D. & H. Shops

The Delaware & Hudson car-building program for 1937 included the construction of 100 steel-sheathed box cars of 40 tons nominal capacity, weighing 41,000 lb. and having a cubical capacity of 3,318 cu. ft. Of this order, 75 cars of riveted and welded construction were built at the Green Island shops. The remaining 25 were built at the Oneonta shops; 10 of the cars built at Oneonta are of welded construction while the remaining 15 are



The welding jig at station 3 at Green Island—Trucks with center-sill sections arriving from station 2 are on the adjacent truck

welded with the exception of the ends, which are partially welded to the roofs and are riveted to the sides and end sills. The shop facilities for building the cars are quite different at the two shops, thereby requiring different movements for handling the materials during the various fabricating operations.

Construction of Cars at Green Island

The 75 cars built at the D. & H. Green Island shops were erected by the spot system. The description of the work completed at each station is given in the following paragraphs:

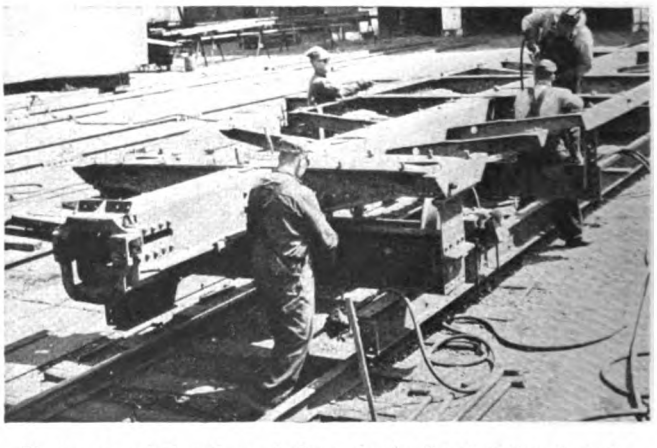
Station No. 1—Truck Assembly—The trucks with integral cast-steel side frames were assembled by two men with the aid of a 2-ton hoist maintained on a hand truck. The trucks, complete with brake levers, bottom rods, AZee brake hanger suspensions, were then rolled to the assembly track.

Station No. 2—At this station a pair of trucks was placed on the assembly track about 30 ft. apart. Two Z-section A.A.R. center sills of Manten steel, weighing 31.3 lb. per ft., were lifted from storage by a tractor crane and placed on the trucks. The trucks and sills were then rolled down the assembly truck to station No. 3.

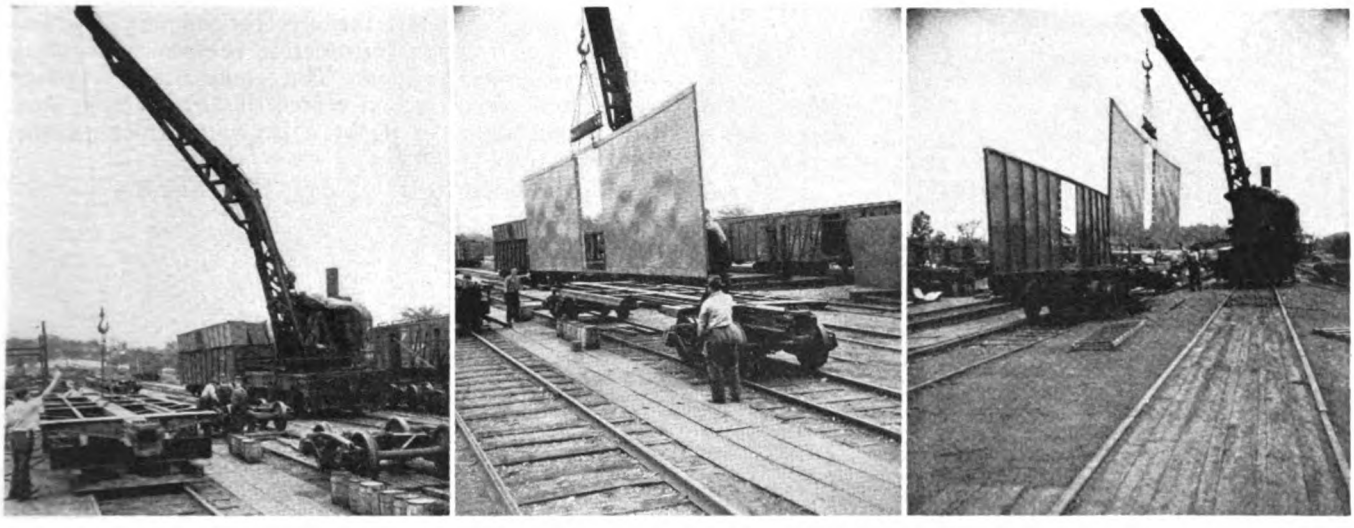
Station No. 3—An erecting crane, on a track adjacent to the assembly track, lifts the center-sill sections from the trucks to a center-sill welding jig. This erecting crane is a wreck crane with the boom extended tem-



The completed center sill being lowered to the underframe jig at station 4 at Green Island



Riveters completing the underframe in the jig at station 4 at the Green Island shops



Left: Transferring the underframe from station 4 to the trucks at station 5. Center and right: Applying the car sides at station 5 at Green Island

porarily to appropriate length. The swing of the boom is such that all the operations described at stations 3, 4 and 5 can be completed with a minimum of movement on the part of the crane. The sills were clamped in the welding jig bottom side up, after which the bolster center fillers, front and rear draft-gear stops, buffer castings and spacers were applied, fitted and riveted. The draft gears were then dropped into position and the sill was tack welded from the bottom side. The sill was then turned over, clamped into position, and continuously welded from end to end.

Station No. 4—The completed center sill was lifted by the crane from the center-sill jig and moved to an underframe jig on which had previously been placed the body-bolster center plates and body-bolster bottom cover plates. Bolster webs, crossbearer webs, and crossties were then applied and bolted in place preparatory to riveting. Three riveters from station No. 3, progressing with the work, riveted side-bearing reinforcement castings in between bolster webs. Body-bolster top cover plates and side-sill reinforcing channels were then bolted in place by one man working ahead of the riveting gang. The top cover plates for the body bolsters were then riveted.

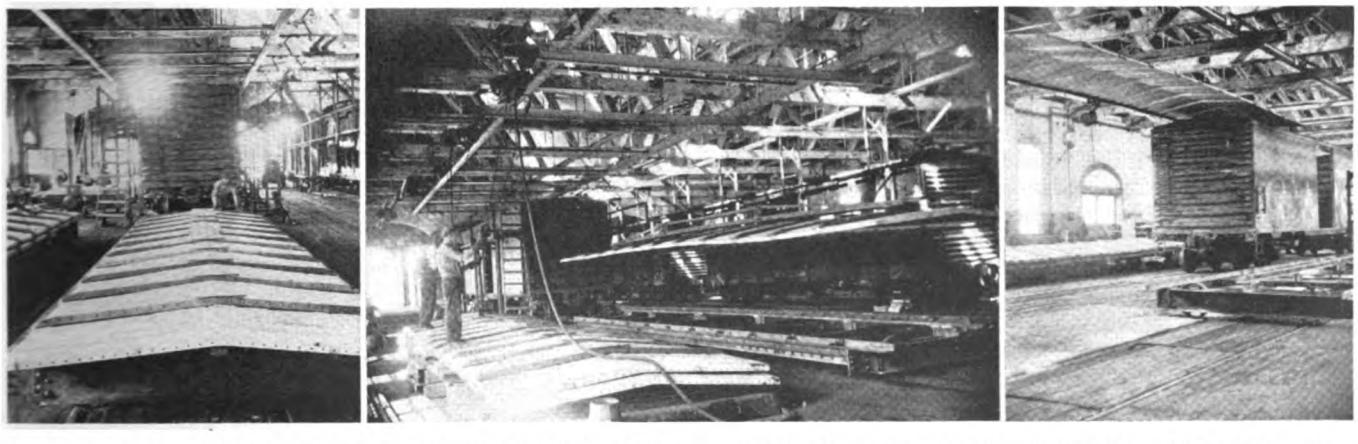
Station No. 5—The underframe was set on the trucks and one-piece sides were set and bolted in position.

Station No. 6—The cars, with the sides bolted and placed in position, were rolled into the shop where the ends were applied by a hoist affixed to the roof beams. The ends were of Dreadnaught design received in two sections and subsequently welded together in a jig. Safety appliance brackets were riveted, as required by I. C. C. safety rules. The ends were applied as explained, fitted, reamed and riveted. The couplers, uncoupling levers and Ajax hand brakes were also applied at this station.

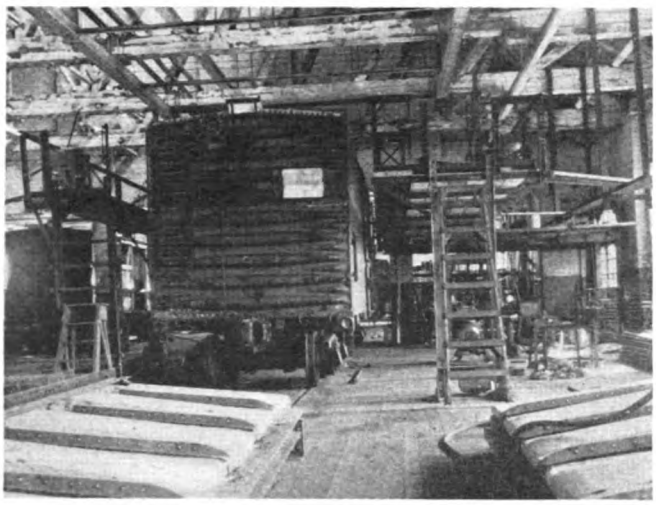
Station No. 7—All roof work was done at station No. 7. The roof, of Chicago-Hutchins Dry-Loading design and received at the shop in sections were placed in a special jig, seam caps were applied, and the assembly was riveted. A special lifting jig was then bolted to the roof. The roof was lifted flush to the roof beams by means of two air hoists. The car was rolled under the roof, which was then lowered, bolted and riveted in position. Doors and door fixtures, AB brake and brake rigging were also applied at this station. The car was then sprayed with red lead.

Station No. 8—The car was rolled down the shop to station No. 8 where floors were applied and fastened with special car bolts, after which nailer strips and lining were applied to the sides and ends. The running boards were also laid out and applied at this station.

Station No. 9—The car was then removed to the paint track where is received two coats of Delaware & Hudson standard color paint, applied by spraying; the lining of the car was sprayed with Sipes enamel oil and the floor given a coat of Balcolac. The outside of the roof was sprayed with two coats of Valdura black after the inside

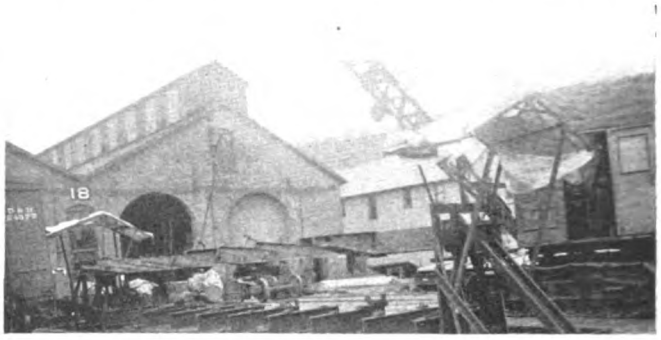


Station 7 at Green Island. Left: The completed roof and its jig. Center: Raising the roof from the jig. Right: The roof hoisted in position, and the car being moved beneath it

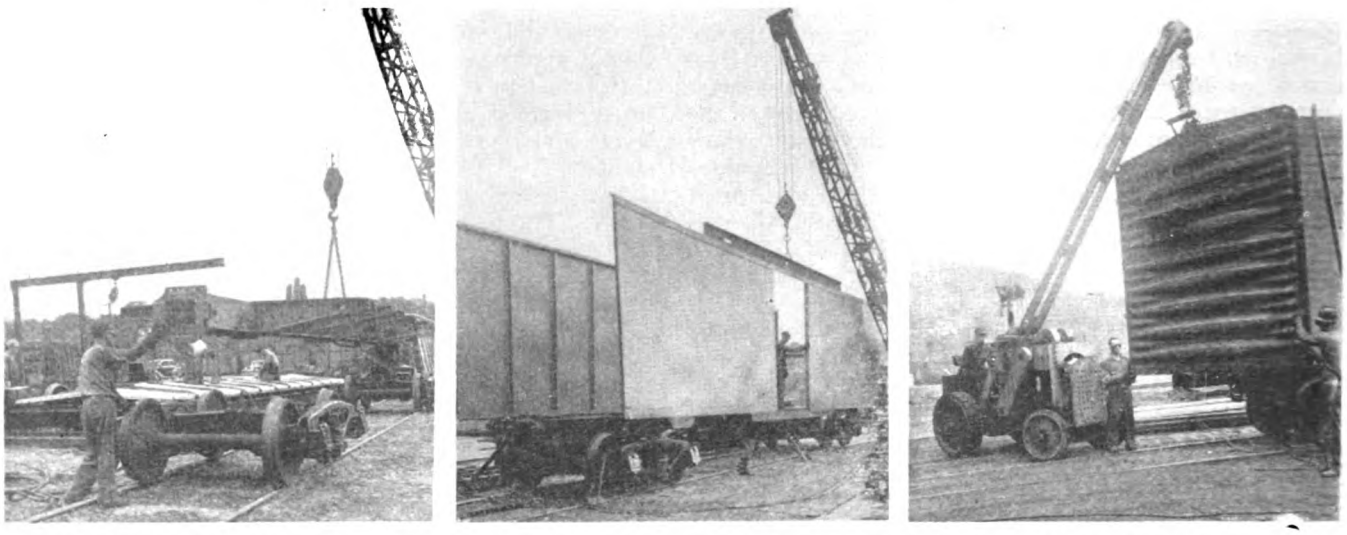


Station 8 at Green Island where floors, lining, running boards, and doors are applied

in a jig which included facilities for mounting the underframe on trunnions in order to perform all welding in a down or flat position. The sequence of operations was as follows: Z-section center sills of Man-ten steel were swung onto the jig by a Browning tractor crane,



The trunnion welding jig at the Oneonta shops with a completed underframe rotated to a horizontal position



Erecting scenes at the Oneonta shops. Left: Lowering the underframe under the trucks. The jig for assembling roofs shown in the background. Center: Applying the car sides. Right: Applying the Dreadnaught car ends

and outside had been sprayed with one coat of galvanized iron primer. The car was then stenciled by the spray method and turned over to the transportation department for revenue service.

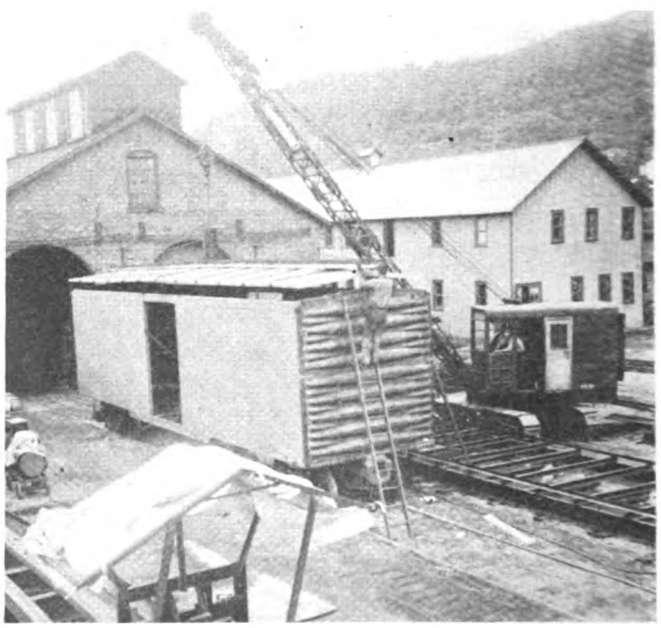
Construction of Cars at Oneonta

The cars built at Oneonta were erected at one centrally located position on the lead track outside the main car shop. Jigs were used for assembling the car ends, roof and underframe, the jigs being located adjacent to the erecting position. The parts assembled on the various jigs were moved directly to the car for assembly, or to storage if the work on the parts proceeded faster than that required for assembly.

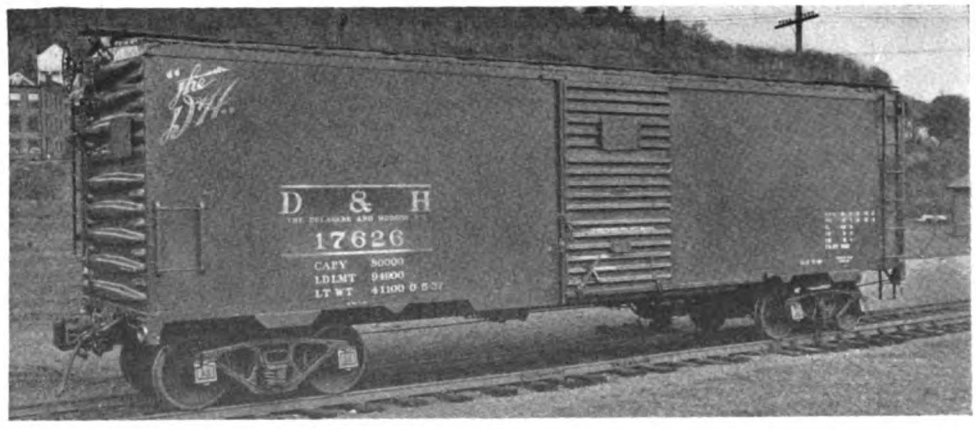
Dreadnaught car ends delivered to the shop in two sections, were welded together in a jig, after which running board, Wine ladders, brake step, Ajax hand-brake and hand-hold brackets were riveted in position.

The roof, of Chicago-Hutchins Dry-Lading design, were delivered to the shop in sections and assembled in a roof jig. These sections were applied to the jig together with the seam caps, after which the caps were riveted in position with a Chicago Pneumatic riveter. As the riveting progressed the running boards were measured, drilled and bolted into position.

The underframes of the cars were completely welded



Applying the car roof at Oneonta—the car is completed in the shop shown in the background



One of the completed 40-ton nominal capacity box cars built in the D. & H. shops

after which front and back draft-gear stops, buffer castings, center-sill spacers at crossties and cross bearers were welded to one of the Z-sections. The two Z-sections were then clamped down on the jig. The seam between the two Z-sill sections was then welded from the top for its entire length. The sills were then turned over and the other side of the draft-gear stops and buffer castings welded to the other Z-section. The coupler yokes and draft-gear were dropped into position while the sills were bottom side up, after which the bottom side of the draft-gear stops were welded. At the completion of this work, the draft-gear carrier irons were bolted in place.

The center sill was then tipped right side up for assembling the top and bottom body-bolster plates, webs, crossties, cross bearers and cross bearer cover plates, all these parts being welded in place. The underframe was mounted in the trunnion jig and rotated so that all remaining welding could be done in a down or flat position.

After the welding operations were completed, the underframe was picked up by the Browning tractor crane and set on the trucks which were brought from a truck-assembly station and placed on the assembly track.

The sides of the cars, of all-welded construction built by the Greenville Steel Car Company, were moved from storage and applied to the underframe by the Browning crawler crane. With the sides held temporarily in place, the ends were moved from storage or directly from the welding jig by a tractor crane, applied to the cars and bolted to the sides preparatory to final welding or riveting. The diagonal floor braces, Z-bar floor supports, and AB brake brackets were then welded in position, and the AB brake cylinder and reservoir bolted in place.

Ten of the order of 25 welded cars have the sides welded to the ends while the remaining 15 cars have the sides riveted to the ends. The brake-lever guides and brake-lever fulcrums were then applied. Meanwhile the door track, stops and Youngstown steel door with Camel fixtures were applied.

The roof was then lifted from storage, or directly from roof jig, by the Browning tractor crane and set in position. It was fitted, the seam caps riveted, and welded to the Z-bar side plates at the sides and the roof end sheets partially welded to the ends. Finally, when this work was completed, all joints were welded.

After these operations, the car was run onto the paint track where it was cleaned and sprayed with red lead. A heavy coat of Continental cement was applied for a height of 2 ft. at the inside ends and sides of the cars to prevent corrosion.

The cars were then run into the shop where the floor, end and side lining were applied. The air-brake equipment was then applied. The car was then removed to the paint track where all painting, similar to that explained for the work at the Green Island shops, was applied.

The Lubrication of Railroad Equipment*

By L. Grisbaum†

The problems of railroad journal lubrication have been with us a long time, and through years of constant contact with them, a vast store of knowledge and experience has been accumulated. Through research and study promoted by the company with which the writer is associated facts were proven or developed and segregated from opinions and, by an orderly arrangement of the factual knowledge so developed, we believe that much has been done to raise journal lubrication to the same high plane as other major lubricating problems. At least, many service applications strongly indicate that journal assemblies can be set up and operated with reasonable assurance of continued and uninterrupted service.

In evaluating the great amount of work and study we have done in the past few years, I believe our research to be more recreative than creative. There are close to 21 million journal-box assemblies in operation on our railroads. We felt that any development to be economically sound and acceptable must use the present equipment as the foundation for improvement. Our work, therefore, has been chiefly concerned with attempting to ascertain those things that are causing trouble from design, operation and practice; to find ways of correcting where possible the faults of operation; and to improve where necessary the mechanical weaknesses without interfering with the basic design or interchangeabilty.

Unfortunately, there is no one or even several corrective factors that will solve our problem. Our troubles originate in many ways and from many causes: The mechanical factor is our greatest concern, operation adds its share and lubrication difficulties are of some consequence.

We are told: "The intrinsic and economic worth of anything is its usage value." No one can question the intrinsic worth of the car-axle assembly. At the eighth annual convention of the Master Car Builders' Association held in Cincinnati, Ohio, in 1874, the present design was accepted as standard, and since that time there has been but a few minor changes or improvements, most of which have been metallurgical. The

* Presented at a meeting of the Eastern Car Foreman's Association held at the Engineering Societies Building, New York, November 16, 1937.

† Railway Service and Supply Corporation, Indianapolis, Ind.

design was certainly well conceived and executed, for it has stood the test of years of severe service. Its economic worth, however, is subject to debate chiefly because, in my opinion, it has been abused in practice. When the design was made, 62 years ago, the maximum size journal was 3¼ in. by 7 in. Today 7-in. by 14-in. journals are not uncommon. As loads were increased requiring larger journals no new design was incorporated; instead, all parts of the assembly were simply stepped up by comparison. With heavier loads came longer cars, higher speeds, longer trains, improved brakes, resulting in more rapid deceleration, and many other contributing influences. With all these increased demands of operation our permissible tolerances remain the same, or were from time to time made more liberal. When we had smaller equipment, a great many of the practices that are causing trouble today were not vital. Excess lateral was not as disturbing an influence, loads and speed were not as conducive to temperature influence on the deformation of the bearing with its effect of load concentration, and the demands of operation itself were not as exacting.

Cost of Bearings and Lubrication

Most mechanical men are more concerned with keeping equipment running with as few failures as possible than they are with the economy of operation. We have made miles per hot boxes our operating bible. If maintenance costs were made a definite part of the lubrication accounting picture, as is true in industrial lubrication, I feel that we would have far less replacement of defective parts and certainly fewer failures. The direct cost of lubricating materials and the labor of applying and handling is in excess of $15,000,000, annually. To arrive at the relative operating significance of lubricating cost, we should add to the above cost the cost of bearings and all other items contained in the indirect cost of lubrication, which those familiar with the cost of locomotive and car repairs will readily recognize as a figure several times that of the direct cost of lubrication.

Following is a statistical example illustrating the possibilities of economy in indirect lubrication costs. The Copper and Brass Research Association from its survey of the bearing and bushing industry estimated that there are 260,000 tons of bearing bronze in locomotives and car journal bearings on our railroads, and that the annual turnover amounts to 70,500 tons, of which 80 per cent or 56,225 tons are freight car bearings. On a basis of a 5½ in. by 10-in. journal bearing containing approximately 20 lb. of bronze, this means that the removal and re-application of approximately 5,500,000 journal bearings annually or over 2.5 bearings per car. To check this figure we made a survey of our own for a period of three years on two Class I eastern railroads and found that on a basis of 10,000 car miles one road used an average of from 2.6 to 2.96 bearings per car, and the other road used from 1.97 to 2.54 bearings per car.

We all know that a very small percentage of these bearings were involved in actual failure and further that 5 per cent would be a conservative estimate of the number of bearings actually worn through the linings. The great majority were removed for cracked and broken brass or linings, loose linings and end wear. Some defects and failures naturally resulted from faulty bearings, but the majority were removed due to mechanical conditions of construction and operation. To me, this figure of less than 5,000 car miles per bearing applied represents considerable economic waste, particularly when there are many bearings in service producing many times this number of miles in a very satisfactory manner.

While journal bearings, including the labor costs involved to handle and apply, is the major expense of indirect lubrication cost, cut journals caused by faulty lubrication or mechanical defect is another item of some consequence. On one railroad operating 34,000 freight cars, 12,000 pairs of wheels were removed in running repairs in 1934. Of this number 29.7 per cent were removed for cut journals.

The foregoing illustrations are used to point out forcibly that failures, regardless of how reported, are a poor criterion of operating efficiency and are certainly misleading as a measure of lubrication economy. When we have reduced the indirect costs of lubrication by eliminating defects, failures will automatically be reduced.

We all know that the design of the journal assembly is not perfect, particularly for present-day operation, and that we can normally anticipate some trouble from its deficiencies; however, by taking adequate advantage of the technological developments available, a great deal of the trouble can be eliminated. Again, by correcting erroneous practices coupled with intelligent supervision and inspection, further savings are possible.

We all know that indirect self-lubrication falls short of complete dependability. Much has been learned in the past few years about oil and waste performance; however its weakness as a lubricating medium has been greatly minimized. Lubrication can be the least of our worries in journal operation; in fact, if the mechanical phase of our problem was as well advanced and as generally accepted as the available lubricating practice, we would be close to our goal of placing car lubrication in step with other major lubrication problems.

A Universal Problem

Let me remind you that car-journal lubrication is a universal problem and must be treated as such. The benefits of uniformity in journal lubrication cannot be over estimated. Unfortunately, the maximum good cannot accrue as long as a number of roads insist on using materials and following practices that are definitely not suited to the best interests of general improvement. If the rules governing lubrication and operation of interchange equipment are not adequate to serve their purpose, let them be changed. There is no justification for us to be critical of the equipment that has served us so well. There is plenty of evidence for justifiable self-criticism, both as individuals and organizations, for neglecting to advance the efficiency of the journal assembly in keeping with the many other railroad developments. The actual situation in regard to railroad-journal operation was summed up by the president of a large roller-bearing manufacturing company, who stated:

"I admit frankly, from a contact of 22 years with the antifriction-bearing business, that if the plain bearing had been developed by specialists and always kept in the hands of its friends, our problem might not have been so easy as it has been.

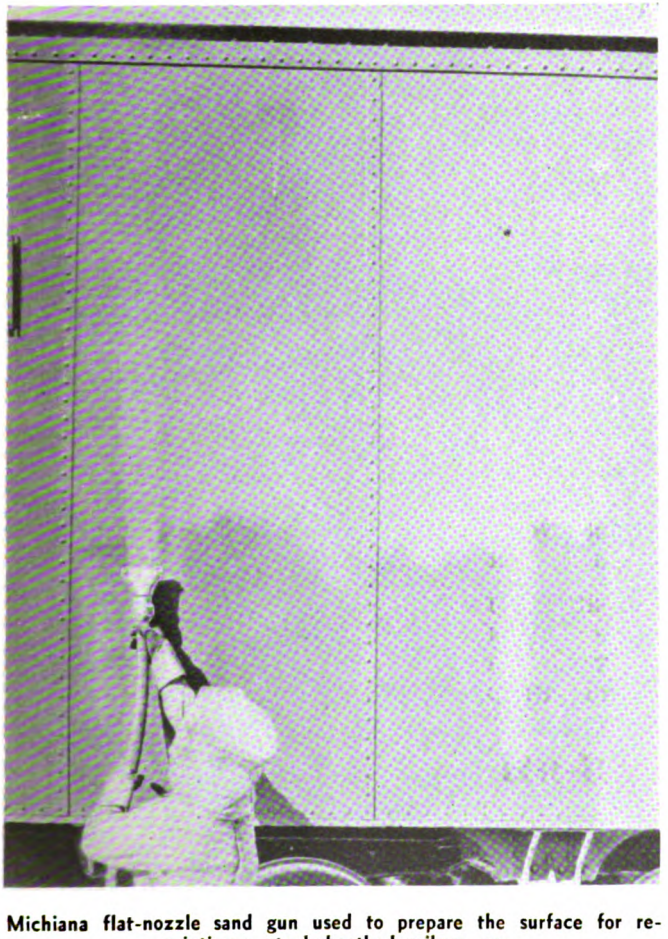
"That, I think, is an excellent example of the axiom: 'What is everybody's business is nobody's business.' Every one has assumed that he knew everything that was to be known about a plain bearing, and the result has been that there have been too many wrong principles in the design, manufacture, and application of plain bearings.

"The antifriction bearing has been developed by its friends, and through that concentration of effort the sum total of all the information which has been available has been disseminated, I think usually wisely, for the benefit of the user."

I admit that the car-journal bearing and all other parts in juxtaposition to it is the business of a lot of people. I refuse to believe, however, that the mechanical railroad officials will not take the responsibility for making the journal parts a serious portion of their business. There has been a lot of concentrated effort expended on the friction journal bearing since the above quotation was first made, and the information resulting from this effort is available to you. We have found a true bill in the indictment that there has been too many wrong principles in design, manufacture and application of the plain journal bearing, and have succeeded to an encouraging degree in correcting a number of the causes for this opinion. Not only was it possible to aid lubrication greatly by a modification in design of the plain bearings, but by minor refinements in manufacturing decided mechanical advantages were also obtained.

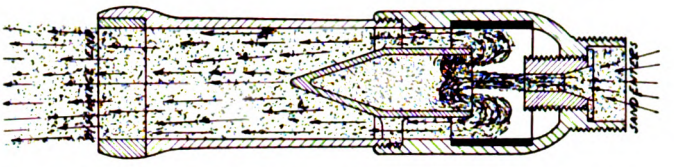
Sand Blast Gun With Flat-Mouthed Orifice

A new sand blast gun, now being manufactured by the Michiana Products Corporation, Michigan City, Ind., incorporates features of design and principle said to produce better surfaces for painting and finishing wood and steel in much less time and without injury to the surfaces of the materials. Exclusive license agreement for the manufacture and sale of this gun has been made with W. Schultz, shop superintendent, Atchison, Topeka & Santa Fe, Wichita, Kan., who is the inventor. The gun has been employed for cleaning wood refrigerator and steel-sheathed cars preparatory for refinishing, for several years.



Michiana flat-nozzle sand gun used to prepare the surface for repainting a steel-sheathed railway car

This gun, as shown in the drawing, has a chamber in



Sketch showing longitudinal section and principle of the Michiana sand gun

which the sand meets a baffle which sets up a whirling motion reducing the sand particles and increasing the number of cutting edges. Sand is delivered under 80 to 100 lb. air pressure through a flattened orifice fitted with abrasive-resistant alloy-steel lips. The result is a flat stream of sand expelled under uniform pressure. It is said that this design permits the use of lower cost sand, removes grime, grease and old finishes faster, and reduces buckling to a minimum on light materials without cutting or pitting the surfaces. Micro-photographs are said to show a smooth, clean surface.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.A.R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Tank Shifted on Car Equipped With Cradle-Casting Center Anchorage

On September 19, 1935, the Grand Trunk delivered to the Pere Marquette at Muskegon, Mich., an empty tank car owned by the Keith Railway Equipment Company, which was damaged as follows: Left steel center-sill channel bent down 5/8 in. and bent out 1 3/4 in. for a length of 5 ft. in the center of the car; right steel center-sill channel bent out 1/4 in. in three places; tank anchor casting on tank bent, A and B ends; tank bottom sheet bent, A and B ends; tank anchor casting on center sills broken, A end; longitudinal tank supports, 3 3/4 in. by 6 in. by 6 ft., broken on A end; and horizontal tank support, 5 1/2 in. by 14 in. by 40 in., broken on A end. On October 8 the Pere Marquette sent to the car owners, a joint inspection, and estimated the cost of repairs at $125 plus the cost of one anchor casting from the car owner. The car owner ordered the car to its home shops for repairs and inspection and, after arrival, requested another joint inspection which was made on November 5 by the Pere Marquette and the Keith Railway Equipment Company; the same defects were noted as before. The owner contended that the damage to the car would be impossible in ordinary handling, and that, according to Rule 44, the Pere Marquette should furnish a statement showing the circumstances under which the damage occurred in order to establish responsibility of the car owners for repairs. Under note of Section 6 of Rule 44, tank shifting and damage resulting from tank shifting on cars equipped with cradle-casting center anchorage is the owner's responsibility. However, in this case the

owner contended the damage was done prior to the shifting of the tank. To substantiate its contention, the car owner quoted from the report of the Pere Marquette: "One steel center sill bent out 1¾ in. and bent down ⅝ in., which caused the breakage of the tank anchor casting." The Pere Marquette contended that the car was neither derailed, cornered, sideswiped nor otherwise damaged, according to Rule 32, on the Pere Marquette. An investigation of the car's movement over the G. T. and the C. M. St. P. & P., which also handled it between Muskegon and Milwaukee, likewise showed that it was not damaged, as classified under Rule 32, on their rails. The Pere Marquette maintained that the extent of damage to the car did not warrant a statement being furnished to the car owner under Rule 44 because the sills were not bent in excess of 2½ in., the greatest deflection being 1¾ in. on one sill, and that the owner was responsible.

In a decision rendered November 12, 1936, the Arbitration Committee stated that: "The shifting of the tank on its underframe in conjunction with damage to the cradle casting center anchorage and deflection in center sills, is owner's defects per second note under Item (6) of Rule 44 and does not require that a statement of circumstance be furnished to car owner. The evidence does not indicate that the car was subjected to any unfair usage conditions under Rule 32. The contention of the Pere Marquette is sustained."—*Case No. 1752, Keith Railway Equipment Company versus Pere Marquette.*

Questions and Answers On the AB Brake

Operation of the Equipment (Continued)

233—*Q.—What movement occurs in the service portion?* A.—When the brake-pipe pressure becomes slightly greater than the auxiliary-reservoir pressure, the service piston and slide valve are moved to either retarded-recharge or full-release position and the brake will be released and reservoirs recharged as previously described.

234—*Q.—When do the emergency piston and the slide valve assume charging position?* A.—The quick-action chamber is being charged through the charging choke, and the return spring will move the piston and the slide valve from accelerated release to charging position as soon as the air pressures on both sides of the emergency piston become substantially equal.

235—*Q.—Is communication then open between the brake cylinder and the brake pipe?* A.—No. The movement of the emergency slide valve blanks the port in its seat, thereby cutting off communication.

236—*Q.—Under what other conditions may the valve assume accelerated release position?* A.—The emergency piston and slide valve may assume this position on head-end cars when recharging.

237—*Q.—Will this have any effect?* A.—Not at this time.

238—*Q.—Why not?* A.—The brake-pipe pressure will be sufficiently higher than the brake-cylinder pressure to prevent unseating of the accelerated release checks.

General

239—*Q.—When manually releasing an individual brake by means of the duplex release valve, on the service portion, with the brake pipe charged, how should the release-valve handle be operated?* A.—Pull the handle only far enough to open the auxiliary check valve.

240—*Q.—How long should the check be kept open?* A.—Only until the brake-cylinder exhaust is heard starting.

241—*Q.—With no air in the brake pipe, how should the release-valve handle be operated?* A.—Drain both auxiliary and emergency reservoirs by pulling the handle its full travel.

242—*Q.—How long should the handle be held in this position?* A.—Until all the air is drained.

Combination Brush And Water Spray

The illustrated combination brush and water spray used for cleaning passenger cars has a tubular handle which it attached to the hose, and water flows up the handle and out of the center of the brush-head. The brush was designed to effect a saving in car-cleaning time inasmuch as the three operations of wetting, brushing, and rinsing are done without interruption. A continuous flood-wash-rinse action quickly removes dirt without harming the finish. In addition to this saving in labor, the spray brush offers an economy of water, inasmuch as the water coming from the brush-head is always in use on the surface of the car. An angle cock at the lower end of the aluminum-tube handle permits control of the water flow. Moreover, the fact that a constant flow of water is under the brush at all times lessens wear on the finish of the car. On the other hand, when the brush and hose are separate, workmen sometimes carelessly scrub dry portions of the surface, damaging the finish.

This product, called the Imperial spray brush, is now used by many leading railroads, including the Illinois Central; Atchison, Topeka and Santa Fe; Chicago, Burlington & Quincy; Chicago, Milwaukee, St. Paul & Pacific; Chicago, Rock Island & Pacific; Great Northern; Norfolk & Southern; and the Bangor & Aroostook. It is made by the Wilson Imperial Company, Newark, N. J.



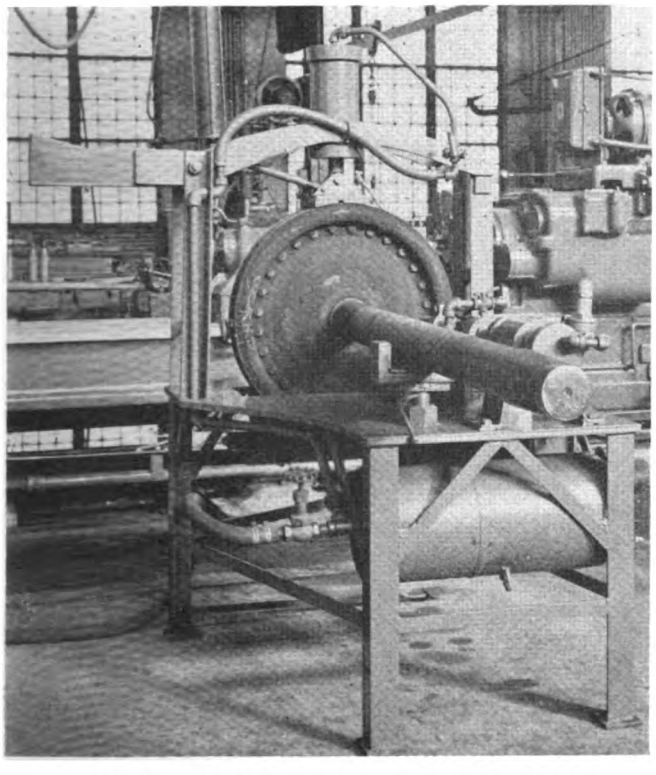
Imperial spray brush features flood-wash-rinse action

IN THE BACK SHOP AND ENGINEHOUSE

Three Shop Devices At Danville

Three devices which greatly expedite the work at the Danville, Ill., shops of the Chicago & Eastern Illinois are shown in the illustrations, including a piston bull-ring riveting machine, an electric boring bar drive and a lagging-mixing machine.

For riveting piston bull rings, the compact and efficient tool shown in the first two illustrations is used. It consists simply of a steel framework and table designed to support the piston on two rollers, a pneumatic clamping device to hold the piston in any desired position and two mechanically-supported air hammers, one of which applies the rivet and backs it up on one side of the piston, while the hammer on the other side forms the head.



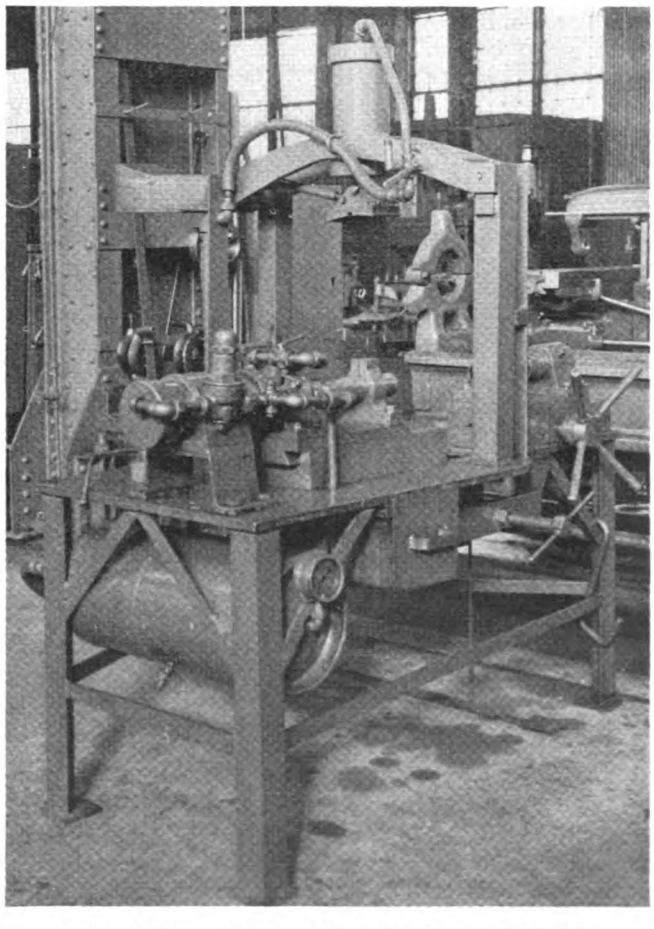
Piston bull-ring riveting machine with piston in place

Referring to the illustrations, the general construction of the machine will be apparent. The table top, made of ¾-in. boiler steel, is 60 in. long by 42 in. wide at the rear and 26 in. wide at the front, mounted on 3-in. angle-iron legs, 32 in. above the shop floor. The overall height of the machine from the top of the clamping cylinder to the shop floor is 76 in. A recess is cut in the rear of the table plate to receive the piston which rests on two 4-in. rollers capable of being drawn together or separated by means of a hand wheel on the front of the machine, thus making possible accurate adjustments of the piston height. The piston rod is supported near the center on a copper-lined bracket which is also adjustable for height by means of thread and nut arrangement.

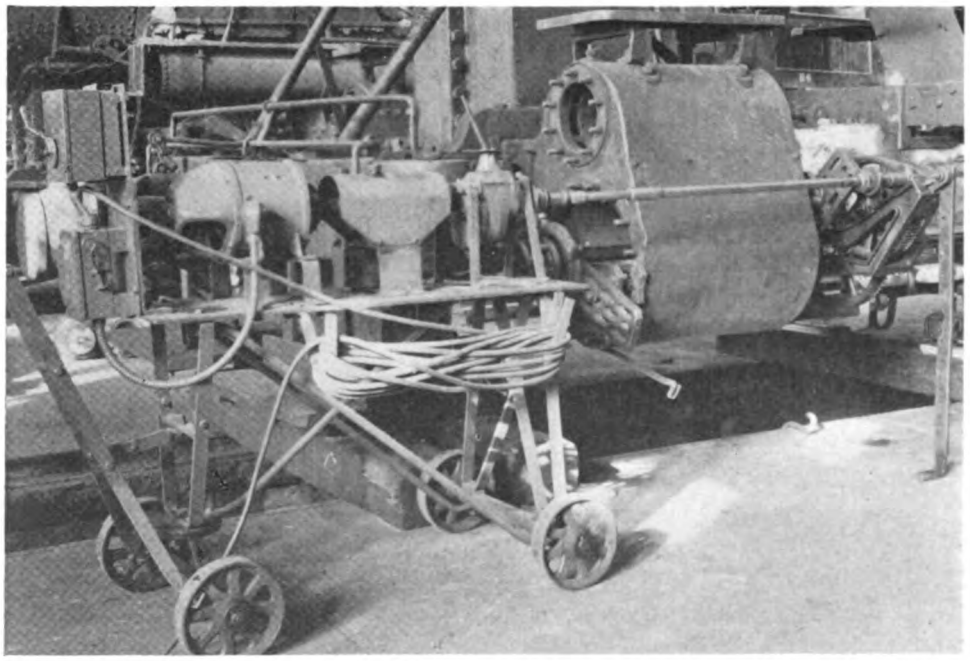
After the piston has been elevated and rotated to the proper position for riveting, air is admitted to the cylinder at the top of the machine which forces a brake-lined shoe against the upper part of the piston and holds it firmly in position during the riveting operation. This holding piston, which has a 5-in. diameter and 10-in. stroke, is mounted in a light but rigid framework counterweighted and pivoted at the left vertical support so that it can be swung upward out of the way while the piston is being applied to or removed from the machine.

Referring to the view of the machine before application of the piston, the air-hammer operating parts are clearly shown. Each air hammer is rigidly mounted in an old lathe crossway which slides in a suitable block firmly secured to the table plate. The V-block and air hammer at the front of the machine are moved forward and backward by means of the small air cylinder illustrated. The piston movement, and consequently the position of the V-block and hammer, is controlled by a small three-way valve conveniently located within easy reach of the operator's hand. The air hammer at the front of the machine is controlled by a foot treadle.

A small equalizing reservoir, welded in place under the table plate, is used primarily to avoid minor fluctuations in air pressure during operation of the air guns. The pressure of air to the small cylinder is limited by means of the pressure-reducing valve, illustrated, in order to avoid forcing the air hammer against the rivet head with too much pressure. The air hammer and crossway at the back of the machine move by a rack



Piston bull-ring riveting machine from the operating side



Portable electric-power unit set up for driving a cylinder boring bar

and pinion operated by the turret handle, illustrated, the operation of the air hammer itself being controlled by hand.

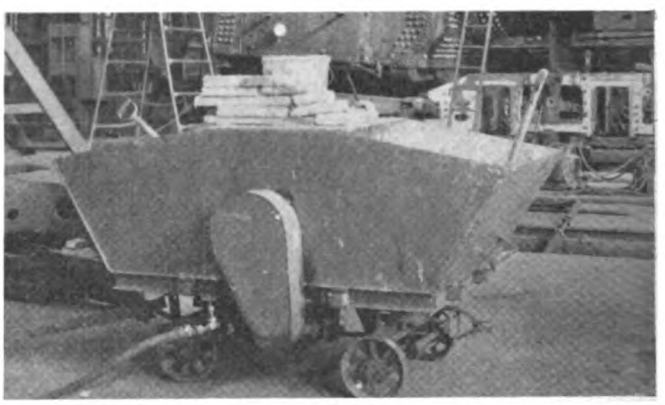
In the operation of this machine, the piston is applied, its position adjusted and the piston clamped in place as described. A hot rivet is placed in the hole which passes through the piston and bull ring. The operator then opens the three-way valve which brings the air hammer at the front of the machine against the rivet head under a substantial pressure, forces the rivet head against the piston and presses the latter firmly against the bull ring. The back hammer is then brought up against the end of the hot rivet; the front hammer is started by the foot treadle and the back hammer by the hand control valve. The hammers are permitted to operate until the new rivet head is well formed when the hammers are stopped, withdrawn from the work, the clamping cylinder released and the piston revolved to the next rivet position.

The machine is operated by a boiler maker, with a helper used to heat rivets. There is a saving of about 50 per cent in labor over the hand riveting method formerly used, and in addition a substantially better job is secured since the piston and bull ring are held more firmly together during the riveting operation which is itself unusually well done with the mechanically-supported hammers.

Electric Boring-Bar Drive

Most cylinder and valve boring operations in locomotive shops are performed with boring bars driven by air motors. By way of contrast, therefore, it may be interesting to show an electric drive unit successfully used for this operation. The power unit consists simply of three elements, namely, a ½-hp. electric motor, a speed reducer and a three-speed gear-change box with a flexible shaft connection to the boring bar.

Referring to the illustration, an Underwood boring bar will be seen set up in a locomotive cylinder, being driven through a universal drive shaft including two flexible joints and one slip joint. The power unit is mounted on a ½-in. by 18-in. by 36-in. steel table plate, equipped with suitably braced steel supporting legs and truck wheels for easy portability about the shop. The switch box and starting box are mounted on a vertical bracket bolted to the table plate, thus making the power unit compact and convenient in operation. A long electric cable, neatly wound on supporting hooks, as illustrated, permits operation of this power unit at considerable distances from the source of electric power supply when necessary.



Small portable lagging-mixing machine which can be operated close to the locomotive being lagged

The particular advantages of this power unit are its economy, ease of operation and the fact that three speeds are available for driving the boring bar. In addition, the unit is easily portable and can be readily moved to any part of the shop where it can be coupled to a boring bar and placed in operation without delay. The use of a flexible drive shaft eliminates the necessity of accurately slinging the power unit exactly parallel with the boring bar.

Portable Lagging Mixer

An unusually neat and effective portable lagging mixer is shown in another of the illustrations. It consists essentially of a welded steel box, made of $\frac{3}{16}$-in. plate, 43 in. long by 36 in. wide by 26 in. high, mounted on a shop truck frame. The spider or mixing element in this box is made of ¼-in. sheet steel, comprising four blades set at 90 deg. with each other and having 12 notched teeth per blade, the blades revolving at a speed of about 50 r.p.m.

Broken pieces of lagging with a sufficient amount of water are fed into this machine and the action of the revolving spider has the effect of shreading the lagging

and mixing it thoroughly, ready for reapplication to the boiler.

In the interest of safety, the spider is shielded with steel finger bars. The spider is driven by a reversible air motor and sprocket-chain drive, the motor being mounted under the truck frame, as shown in the illustration. Asbestos is taken from the locomotive and applied in this device, water being added and the mixture worked to just the right consistency for reapplication.

Hydraulic Press Brake And Flanging Machine

A new type of hydraulic press brake with flanging attachment which appears adapted to extensive use in railway boiler shops, has been developed recently by the Beatty Machine & Manufacturing Company, Hammond, Ind. As shown in the illustrations, this machine consists of a press brake, designed to develop 200 tons ram pressure in bending, pressing, straightening and reclaiming steel sheets; also a flanging attachment, capable of bending ¾-in. plates and lighter and, therefore, adapted for all types of flanging in connection with boiler and firebox work in locomotive shops.

Referring to the illustrations, the general construction of the machine will be apparent. It is roughly 18 ft. long by 13 ft. high and mounted on a substantial base 10 ft. wide set in the shop floor. It is driven by a 25-hp. electric motor and hydraulic equipment which serves as a single power unit for operating both parts of the machine, through control valves, either separately or together.

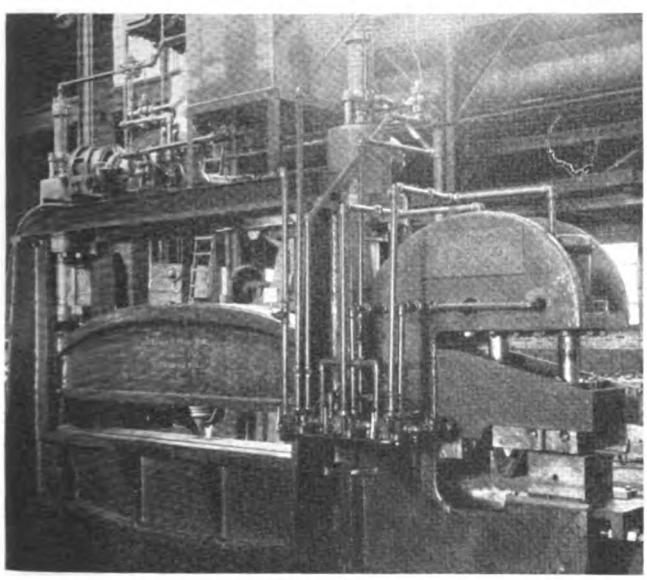
The brake press consists of a heavy cast-iron table, securely bolted to vertical cast-steel end housings which also serve as guides for the ram. The vertical housings are spaced 10 ft. 3 in. apart and tied together at the top by substantial steel I-beams which support the driving motor and the hydraulic equipment. The ram is moved by two 11½-in. hydraulic cylinders, giving a total of 200 tons ram pressure. Two small kicker cylinders on top of the machine give rapid traverse of the ram up and down as required. The maximum ram opening is 25 in. and the power stroke 14 in.

While the entire design of the machine, including the hydraulic equipment and piping is intended to give identical pressures in the two operating cylinders, slightly increased packing resistance in one cylinder, or some other condition, might cause the ram to advance more slowly on one side and, to prevent this possibility, a special mechanical attachment has been developed and applied to the back of the ram.

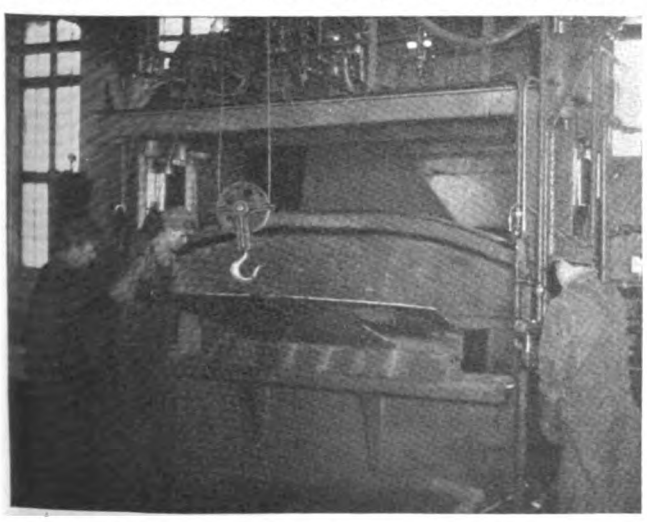
The flanging attachment of this machine is made of box-section cast steel of exceptionally rigid design, bolted to the press brake as indicated. Two 7¼-in. cylinders, developing 40 tons ram pressure each, are provided in the upper jaw of the attachment, the lower jaw of which is equipped with a rectangular anvil or block to support the steel plate during the flanging operation. This bottom block has rounded upper edges to give the correct inside radius of the flanged sheet, any one of four different radii being available by locating the block in the proper position on the square holding pin.

The outer cylinder is equipped with a ram which has an 8¾-in. maximum opening and 8-in. stroke, this ram being used to hold the plate firmly on the bottom block during the flanging operation. The inner cylinder is equipped with a ram having a 14-in. stroke; the lower end of this ram is guided in suitable ways on the main frame of the machine and equipped with a toggle lever arrangement which bends the sheet downward under heavy pressure as the ram moves to its lowest position. In the case of large sheets, the bend or flange is formed progressively in accordance with the usual practice.

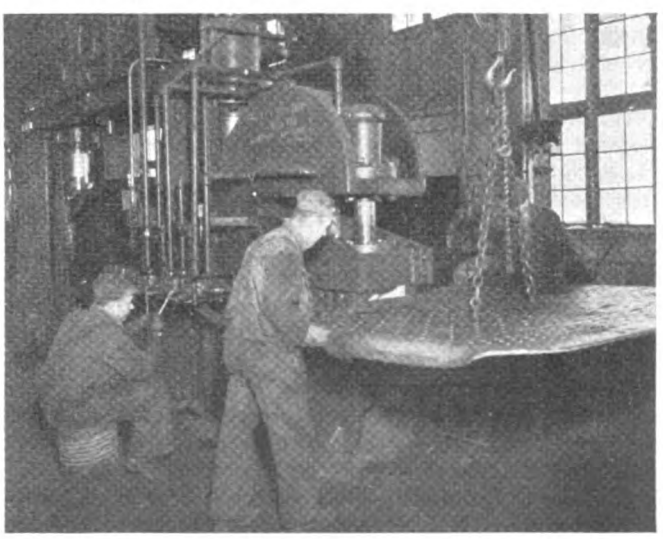
The machine, illustrated, is installed at the Chicago Great Western shops, Oelwein, Iowa, and is the first one of its type ever built.



Beatty combination brake press and hydraulic flanging machine

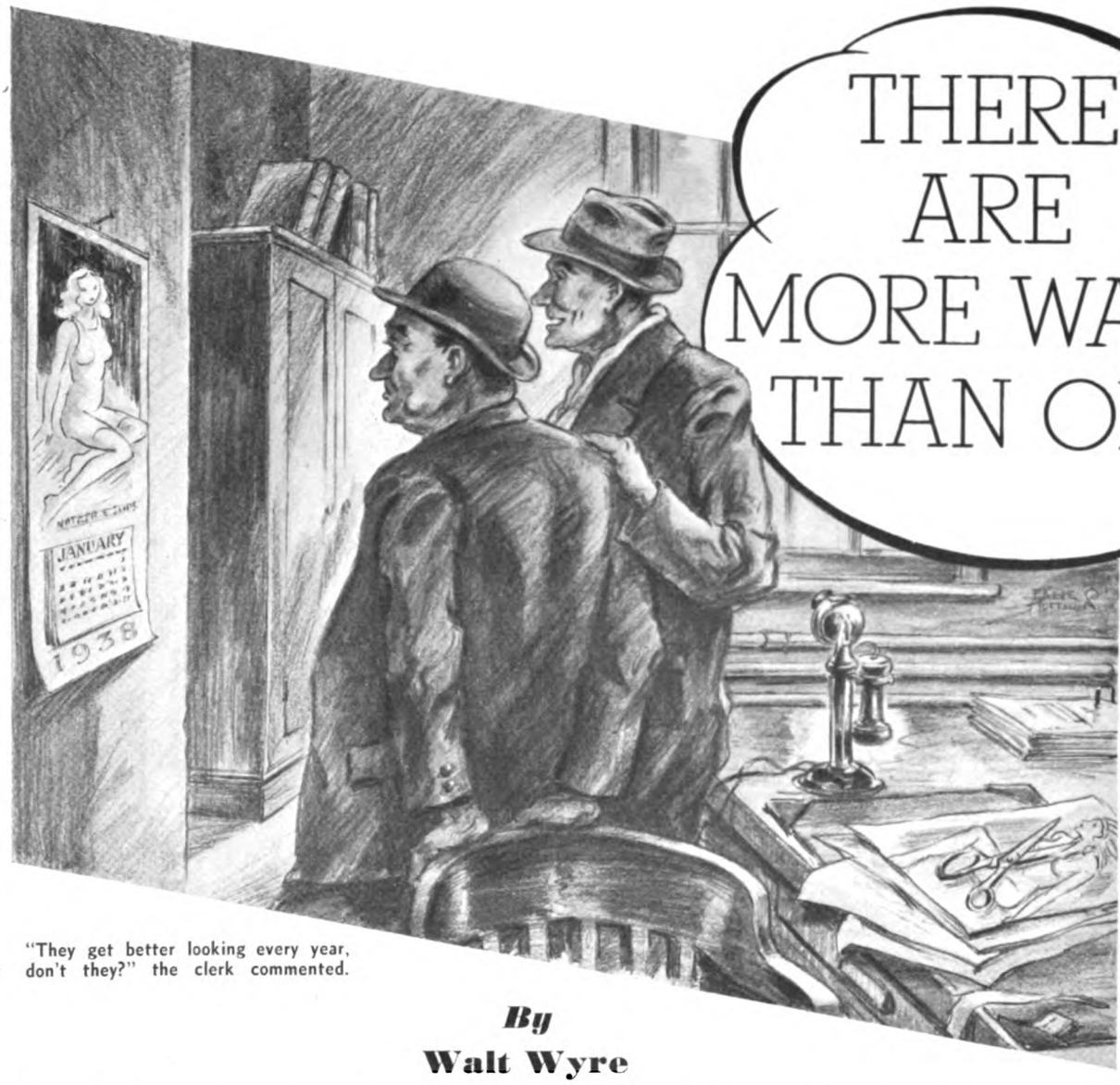


The brake press bending a sheet of boiler plate



Flanging attachment forming the flange on a flue sheet

THERE ARE MORE WAYS THAN ONE



"They get better looking every year, don't they?" the clerk commented.

By
Walt Wyre

JIM EVANS removed the 1937 calendar from the wall in the roundhouse office and hung a new one in its place. When he had the 1938 calendar securely tacked in place, the foreman carefully cut the picture from the old one and laid it with a pile of pictures cut from calendars of previous years. Some day he was going to have the whole bunch, nearly two dozen, framed. There was one for each year he had been roundhouse foreman for the S. P. & W.

When the picture was laid away, Evans paused a moment to admire the one on the new calendar. After gazing a long moment at the scantily attired miss, his eyes lowered to the word January.

At that moment John Harris, the roundhouse clerk, came in and saw the foreman gazing at the calendar. "They get better looking every year, don't they?" the clerk commented. "Believe I could stand and look at her awhile myself."

"I was just thinking," Evans said.

"Yeah," the clerk grinned, "I have an idea you were, and I bet it wouldn't be hard to guess what you were thinking about."

"It might fool you—this time, anyway. I was thinking it's just a little over two months until the cantaloupes will start moving from the west. Every year they've caught us short of power, but this year I'm going to be ready. Soon as the holiday rush is over, I'm going to start getting locomotives in shape so that by the middle of April, when the cantaloupes come, I'll be ready for them."

"If that's a New Year's resolution, I hope you can stay with it." The clerk handed the foreman a couple of letters.

Both letters were from the master mechanic. Evans read one of them: "Engine performance during the holiday season has been very poor. We had three failures in the past fifteen days which is entirely too many. In addition we have had numerous delays that should have been prevented. Every effort must be made to improve engine performance out of Plainville."

Evans laid the letter down and picked up the other and read: "The holiday rush is about over and it is to be expected that business will fall off considerably in the next few weeks. As a result, our appropriation for the month of January has been reduced twenty per cent. You will arrange working forces to stay within the reduced allowance."

Evans laid the letter on the desk, picked up a pencil, and began to figure. He covered a sheet of yellow clip with figures, then wadded the paper and threw it in the waste basket.

"Hell! It can't be done!" he said aloud.

"What's that that can't be done?" Harris then asked.

"Why, keep the engines going with a twenty per cent cut in the allowance! The way we have been running them the past three weeks, every engine we've got should go over the drop-pit." Evans snorted, clapped his hat on and headed for the roundhouse. On the way he met the hostler coming towards the office.

"The 5082, it's called for 9:20 and it's not ready to come out yet," the hostler said.

Evans looked at his watch, 8:35, and quickened his pace. In the roundhouse, the foreman found the left main rod not yet up on the 5082 and the machinist doing the work nowhere around the locomotive. He found the nut-splitter in the machine shop arguing with a lathe hand.

"What the matter?" Evans asked. "Don't you know the 5082 is called for 9:20?"

"The bushing is too small for the pin," the machinist said.

"It'll run, all right," the lathe man said. "The pin is out of round and tapering. Grease it good—it'll run."

"Have you split the bushing?" Evans asked.

"Yes."

"Well, let's see what it looks like," the foreman said. "Bring it down to the engine."

Both men were right. The bushing was too tight and the pin was egg-shaped and tapering.

If the bushing was taken back to the lathe and a cut taken out, that meant a delay. If it ran hot, it meant a delay. With luck, it might make it.

"Drive it in," Evans said. "Pour some oil on the pin and be sure the rod cup is well filled."

THE bushing ran hot, as Evans expected it would; but the run was made to the next division point without loss of time, as he had hoped. The incident reminded him of something that he already knew. They were using too much brass, renewing too many rod bushings, and a large percentage of it was on account of the conditions of the pins. Most of them were like the left main pin on the 5082. That was one of the conditions he had intended to correct before the rush of the cantaloupe season started.

The engineer who came in on the 5076 reported both piston valves blowing. Evans told Henry Cox to pull the valves.

"What do they look like?" Evans asked the machinist. "Will rings fix 'em up?"

"Rings might do for a couple of trips, but what they need is new bushings and bull rings."

The foreman calipered the bushings and bull rings and headed for the storeroom.

"Do you want me to cut the bushings out?" the machinist inquired as Evans left.

"Hell, no!" Evans said over his shoulder. "Chances are we'd have to wait two weeks until the store department could get some in."

He was at least partly right. The storekeeper showed Evans where valve bushings and bull rings would be if they had any. Like a magician getting ready to pull rabbits from a hat, the storekeeper waved his arms as though challenging the foreman to find a valve bushing or bull ring hidden any place. Unlike the magician, the storekeeper produced no bushings. All he could show was copies of requisitions.

"Build up the bull rings with bronze," Evans told the machinist.

"We're running over the allowance every day," the clerk told Evans that afternoon. "Just thought I'd remind you of that before you go too far into the red.

"Yeah, I knew we were running over, but dammit, can't help it!" Evans wrenched a cover off his plug of "horseshoe." "We've been pounding hell out of the engines, barely holding them long enough to get what jobs had to be done." Evans squirted a deluge of tobacco juice in the cuspidor. "Just because business shows signs of falling off is no reason the ones we do run don't have to be worked."

The foreman went back into his cubby hole that served as his "private" office to do a little figuring. Thirty minutes later he came out without having arrived at any satisfactory conclusion.

"Guess we'll have to cut off some men," Evans told the clerk, "but I don't see who we can get along without."

"Do you want me to make a bulletin?" the clerk asked.

"Yeah," Evans said resignedly. "Let's see —"

The engine inspector interrupted the conversation by coming in at that moment. "The 5091 that just came in —" the inspector began.

"Guess she needs a new locomotive run under the whistle," Evans interrupted.

"No, except for driving boxes pounding, the booster not working, a cut trailer journal, spring hangers worn, a few rod bushings that need renewing, and the feedwater pump won't supply the boiler, she's a pretty good engine."

"Is that all?" Evans inquired.

"That's about all I noticed," the inspector replied. "You see, I didn't finish looking her over after I checked the cab card and found she is due a five-year test tomorrow."

"I'll go look at it myself." The foreman started to go when the inspector stopped him.

"I've got the cab card with me."

The inspector was right, the five-year test was due.

"Never mind the bulletin. With a five-year test in addition to other work, we can't cut off men now. Besides," he added, "I think there'll be enough on the 5091 for classified repairs. That'll take a little off running repairs."

Evans left the office determined that he would at least hold one locomotive until it was in first class condition. He stopped at the inspection pit and told the hostler to run the 5091 over the drop-pit.

THE week went by with very little increase in the net deficit. On the other hand, prospects of balancing the budget for the month seemed as unlikely as the present session of Congress balancing the national budget. Unlike our idealistic lawmakers, Evans knew something had to be done about it. Politicians may point with pride and oratorical eloquence at various Babalonian projects as explanation of governmental deficits, but railroad officials as a rule are not interested in either oratory or fairy tales.

Saturday afternoon Evans sat down in his office to do a little figuring and make a list of the number of men to be cut off. According to figures given him by the clerk, they were nearly four hundred dollars over for the month with fifteen days gone, at least fifteen days would be gone at midnight. Thirteen more week days and three Sundays in the month—Evans chewed the end of his pencil and cocked his eyes at the ceiling. Four hundred dollars over and the 5091 already carrying one hundred dollars more than had been worked on her! At least fifty dollars a day had to be cut off on week days for the rest of the month. Four me-

chanics, four helpers, and two laborers would just about make it. How he would ever manage to get the 5091 finished and do the necessary running repair on engines too was something else to worry about.

But what's one worry more or less in a roundhouse foreman's lot—he has so many they're like snowflakes in a drift.

The telephone rattled abruptly. The clerk answered it. Evans paused with pencil poised as he listened to the clerk.

"Yes, clerk talking . . . What? . . . O.K., I'll tell him. Call you back in a minute."

"What is it?" Evans asked. He knew by the tone the clerk used something was wrong.

"Main pin broke on the 5077," the clerk replied. "Tore up pretty bad, the dispatcher said."

"Where did it happen?"

"Near Middleton. Dispatcher wants to know what engine you're going to send out and he says a machinist will have to be sent to get the 5077 in shape to move."

"It'll be the 5072," Evans said as he opened the door and started for the roundhouse walking so fast he skidded going around the turntable.

The foreman lined up a machinist and helper for the road trip. He told them to load a cutting torch and other tools on the engine to take along.

The 5077 came in to Plainville about seven-fifteen next morning. She was a sorry sight. The air pump was broken, the left cylinder head knocked off and a chunk out of the cylinder casting with it, to say nothing of bent and twisted rods. On top of that there was a little matter of nearly thirty dollars overtime to be considered.

Evans looked the engine over, then told the hostler to shove her in the house. He could start worrying about fixing it up Monday. There was a little matter of figuring how to get a platoon of work done with a squad of men without additional overtime, delays or failures.

MONDAY morning Evans rose at his usual hour, early, but not so very bright. It's too much to expect of any one to be bright getting up from a nice cozy bed when all the neighbors are just turning over to begin their beauty nap. He ate hurriedly, gave his wife half a bushel of kisses—two pecks—and rushed out to find one flat tire on the car. Evans walked.

Some people might have enjoyed the rosy dawn that greeted the foreman as he crunched gravel down the tracks towards the roundhouse. A fleecy layer of cumulus clouds glowed iridescently tinted by the reddish rays of the yet hidden sun. It was a beautiful dawn but Evans didn't enjoy it. The clouds reminded him of the condition of the allowance, in the red.

Two letters were on his desk when Evans reached the office. There was other mail, routine matters to be handled and such, but two of the brown envelopes contained letters about subjects the foreman wasn't anxious to have brought up. In one of the letters the master mechanic hinted rather broadly that engine performance should be improved. Evans read in part: "Engine performance for the past three weeks has been deplorable." Deplorable is the word the master mechanic uses when he wants to emphasize the fact that a condition is getting to the point that if something isn't done immediately, he, the master mechanic, will do something himself.

The other letter ended with: "Plainville has consistently overrun the monthly allowance. Other points on the division have managed to stay within theirs. No excuse will be accepted for overrunning of allowances for the current month."

"Yeah—other points!" Evans snorted aloud, "Sanford has stayed within their allowance by sending all their wrecks, annual and five-year tests to us, like they did the 5091." The foreman bit off a hunk of "horseshoe" and went to the roundhouse.

AFTER getting the work lined up for engines that had to be run, the foreman looked the 5077 over. His first idea was to send the damaged locomotive to the backshop for repairs. He carefully inspected the damaged left cylinder and decided it wasn't damaged too bad to be welded locally. Besides the chunk broken out there was a crack extending back lengthwise of the cylinder about eleven inches. The crack could be V-ed out and welded. He decided to have a hole drilled at the end of the crack to keep it from progressing. Where the chunk was broken out would have to be built up. A row of studs would serve as support for the bronze he would use to build it up with and strengthen the weld. The air pump would have to be replaced.

The foreman walked away from the 5077 shaking his head. There was a lot of work needed to put the engine in condition to run again. How could he stay within his allowance and get the work done too? The master mechanic had said he would accept no excuse.

Evans went back to the office to finish the bulletin he had started Saturday. He wrote out three machinists and helpers, one boilermaker and helper, one coppersmith and helper, three laborers.

Three machinists—that would get Johnson, the best man he had on the drop-pit. That would slow up work on the 5091. Then the coppersmith was needed to finish the pipe work and put the jacket on. The boilermaker would get Barton, the only man he could be sure of doing a good job of welding the broken cylinder. Well, if it had to be done, it had to be. He picked up the piece of clip with the list on it and started to walk over to the clerk's desk.

The phone rang. "It's the superintendent's chief clerk; wants to talk to you," the roundhouse clerk said.

"Hello . . . Yes."

". . . a pile driver and two ditchers, they'll be here this afternoon on the local."

"O.K., we'll get started on them first thing tomorrow . . . Yes, I'll put all the men I can spare to work on them and get them finished soon as possible."

When Evans hung up the receiver he was grinning as he hadn't in several days.

"Want me to make out the bulletin?" The clerk picked up the sheet with the list of men on it to be cut off.

"Tear it up!" Evans said.

"But what about the allowance?" the clerk asked. "Did you get it increased?"

"Not exactly," Evans grinned, "but there'll be a pile driver and a couple of ditchers in here tomorrow to be overhauled. It's going to take a lot of work to get them ready for spring work."

"I see," John Harris nodded. Eight years as roundhouse clerk had taught him a few things. "I'll watch and see that all of the time that should be is charged to the pile driver and ditchers."

"Just one thing," Evans paused in the doorway, "if those ditchers are gasoline driven, be careful about charging boilermakers' time to them."

The foreman headed for the roundhouse whistling what purported to be "Casey Jones."

(*Turn to next left hand page*)

Bulletin No. 1

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Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Reasons for Removing Flexible Staybolt Caps

Q.—What are the reasons for removing the caps from flexible staybolts on a locomotive?—J. M. D.

A.—The reasons for removing the caps from flexible staybolts on locomotive boilers are as follows: (1) To renew a broken staybolt; (2) to renew a fractured sleeve; (3) to inspect a staybolt; (4) to remove and reapply staybolts when applying new firebox sheets; (5) to replace a defective cap or cap gasket and (6) to comply with following I. C. C. rule:

"23 *Method of Testing Flexible Staybolts with Caps.* Except as provided in paragraph (*b*) all staybolts having caps over the outer ends shall have the caps removed at least once every two years and the bolts and sleeves examined for breakage. Each time the hydrostatic test is applied the hammer test required by Rules 21 and 22 shall be made while the boiler is under hydrostatic pressure not less than the allowed working pressure.

"(*b*) When all flexible staybolts with which any boiler is equipped are provided with telltale holes not less than 3/16 in. nor more than 7/32 in. in diameter, extending the entire length of the bolt and into the head not less than one-third of its diameter, and these holes are protected from becoming closed by rust and corrosion by copper plating or other approved method, and are opened and tested, each time the hydrostatic test is applied, with an electrical or other instrument approved by the Bureau of Locomotive Inspection, that will positively indicate when the telltale holes are open their entire length, the caps will not be required to be removed. When this test is completed the hydrostatic test must be applied and all staybolts removed which show leakage through the telltale hole.

"The inner ends of the telltale holes must be kept closed with fireproof porous material that will exclude foreign matter and permit leakage of steam or water, if the bolt is broken or fractured, into the telltale hole. When this test is completed, the ends of the telltale holes shall be closed with material of different color than that removed and a record kept of colors used.

"(*c*) The removal of flexible staybolt caps and other tests shall be reported on the report of inspection Form No. 3 and a proper record kept in the office of the railroad company of the inspections and tests made.

"(*d*) Firebox sheets must be carefully examined at least once every month for mud burn, bulging, and indications of broken staybolts.

"(*e*) Staybolt caps shall be removed or any of the above tests made whenever the United States inspector considers it desirable in order to thoroughly determine the condition of staybolts or staybolt sleeves."

Requirements *a*, *b* and *c* of Rule 23 are interpreted as follows:

"(*a*) When locomotives are stored for one or more full calendar months, the removal of flexible staybolt caps for the purpose of inspection will be due after 24 calendar months' service, provided such service is performed within three consecutive years. Portions of calendar months out of service will not be counted. Time out of service must be properly accounted for by out-of-service reports filed with the United States inspector and notation of months claimed out of service must be made on the back of each subsequent inspection report and cab card.

"(*b*) A locomotive stored when renewals of flexible-staybolt cap removals are due need not be given such test until immediately prior to being returned to service.

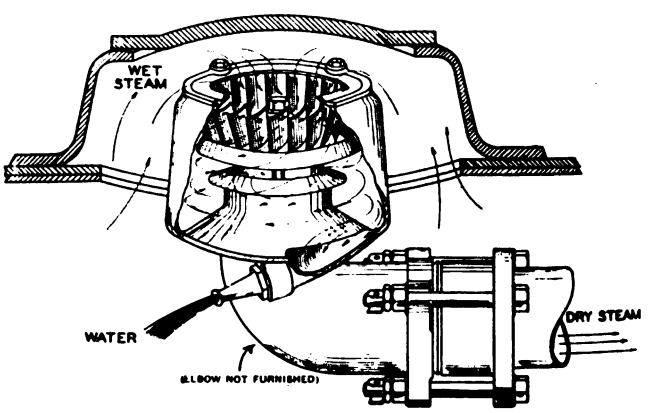
"(*c*) When locomotives are being given their annual inspection and test, flexible staybolt caps should be removed at the time of making this inspection, if they become due for removal before another annual inspection is due, and their removal shown on Form 3. One of the principal reasons urged for extending the time for removal of flexible-staybolt caps from 18 months to two years was for the purpose of bringing the test due at every second annual inspection."

Tests of Elesco Tangential Steam Dryer

Recent tests made by the Superheater Company, New York, with the Elesco Tangential steam dryer on modern locomotives has shown the ability of this device to handle large quantities of water. The tests were made by spraying water into the dryer, in quantities up to 20 per cent of the water evaporated by the boiler. The amount of water sprayed into the dome was accurately measured with a flowmeter and the drop of superheat was read on a pyrometer. The results obtained are shown in the accompanying table. Attention is called to test run No. 2, when 6,756 lb. of water were sprayed into the dome, equivalent to 16.4 per cent moisture and resulting in only a 36-deg. drop in superheat. It is estimated that if it were not for the dryer, there would have been a 244-deg. drop in superheat.

Tests of an Elesco Tangential Steam Dryer

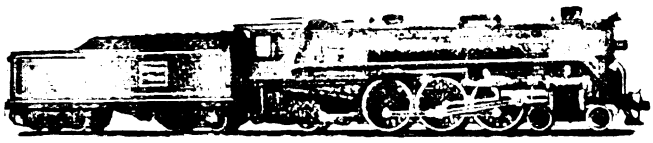
Test No.	1	2
Steam flow through dry pipe, lb. per hr.	34,562	35,073
Water sprayed into dryer:		
Lb. per hr.	1,999	6,756
Per cent	5.5	16.4
Actual drop in superheat, deg. F.	11	36
Calculated drop in superheat if sprayed water had not been separated, deg. F.	87	244
Moisture in dry pipe:		
Lb. per hr.	212	723
Per cent	0.6	2.1
Moisture returned to boiler, lb. per hr.	1,787	6,033
Dryer efficiency, per cent	89.5	89.1



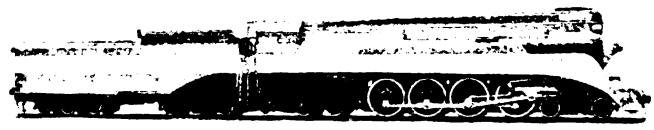
Application of an Elesco tangential steam dryer

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Passenger Power



Boston & Maine R. R.

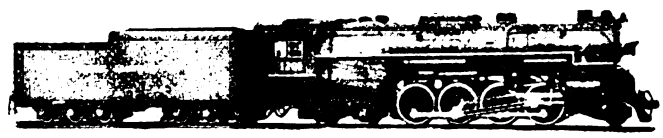


Southern Pacific Company

Freight Power

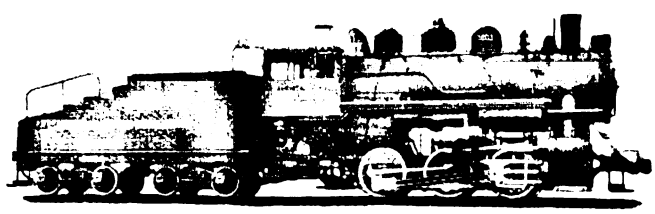


Kansas City Southern Ry.

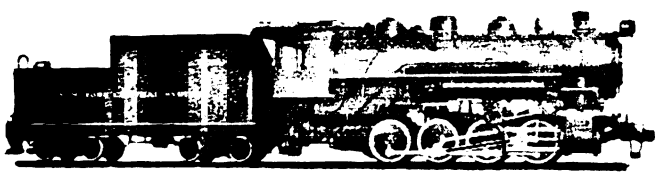


Pere Marquette Ry.

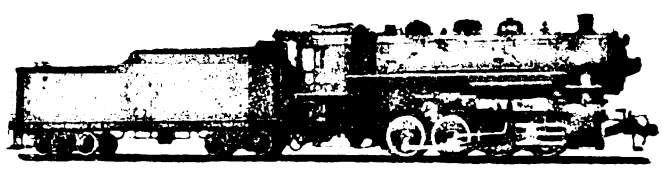
Switching Power



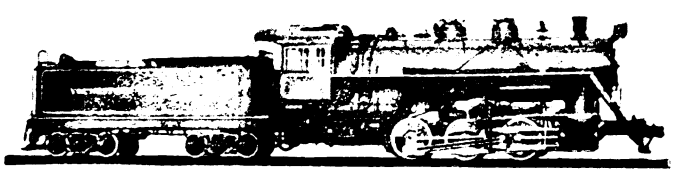
Bauxite & Northern Ry.



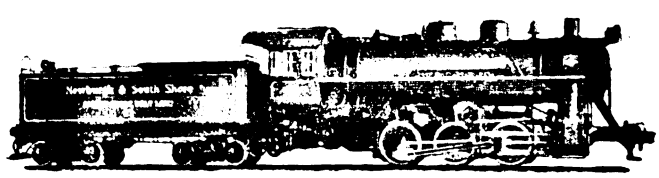
New York Central System



Chicago & Illinois Midland Ry.



Youngstown & Northern R. R.



Newburgh & South Shore Ry.

1937 Lima Built Power

LIMA LOCOMOTIVE WORKS, INCORPORATED, LIMA, OHIO



The modern Mitropa sleeping car

NEWS

C. & O. Huntington Storehouse Destroyed by Fire

THE storehouse of the Chesapeake & Ohio shops at Huntington, W. Va., was destroyed by a fire of undetermined origin on November 28. Officers estimated the loss at $100,000, all of which is covered, however, by insurance. The blaze was confined to the storehouse proper by a protective fire wall and did not spread to the remainder of the shop building, which will remain in operation. The shop telephone system also suffered minor damage.

Improvement Programs

Atchison, Topeka & Santa Fe.—Directors of the Santa Fe have authorized the purchase of stainless steel passenger cars and Diesel locomotives to cost $4,800,000.

Norfolk & Western.—A program of general improvements for the immediate future, involving an expenditure of approximately $3,700,000, has been announced by the Norfolk & Western. The program includes among other items the purchase of shop tools to cost about $200,000 and 4,000 sets of improved (AB) air brakes for application to freight cars.

St. Louis-Southwestern.—Expenditure of $1,558,000 by the St. Louis-Southwestern for improvements to rolling stock and right-of-way in 1938 has been approved by the federal district court. Of this amount, $565,000 is for 50 freight cars and two passenger cafe cars and $157,000 is for shops and roundhouses.

Locomotive Tire Manual

IN Circular D.V.-929 just issued by the A.A.R. Mechanical Division through the office of Secretary V. R. Hawthorne, the statement is made that one of the most important subjects before the mechanical department of American railways is that of locomotive tire work. Large sums of money are expended in the purchase, machining and application of tires.

Based upon the reports of tire failures from a large proportion of railroads of the country, the Committee on Locomotive Construction has been impressed with the lack of appreciation on the part of many shop mechanics, foremen, and even officers, of the existence of improper shop practices in effect, including care of tires in handling and storage, machining of tires and wheel centers, application and damage due to welding. It is essential that employees who are responsible for tire work in the shops and inspection on the line, should have a thorough understanding of their work. It is for this reason that this manual has been prepared and approved by letter ballot. It contains information for inspectors, mechanics and supervisors.

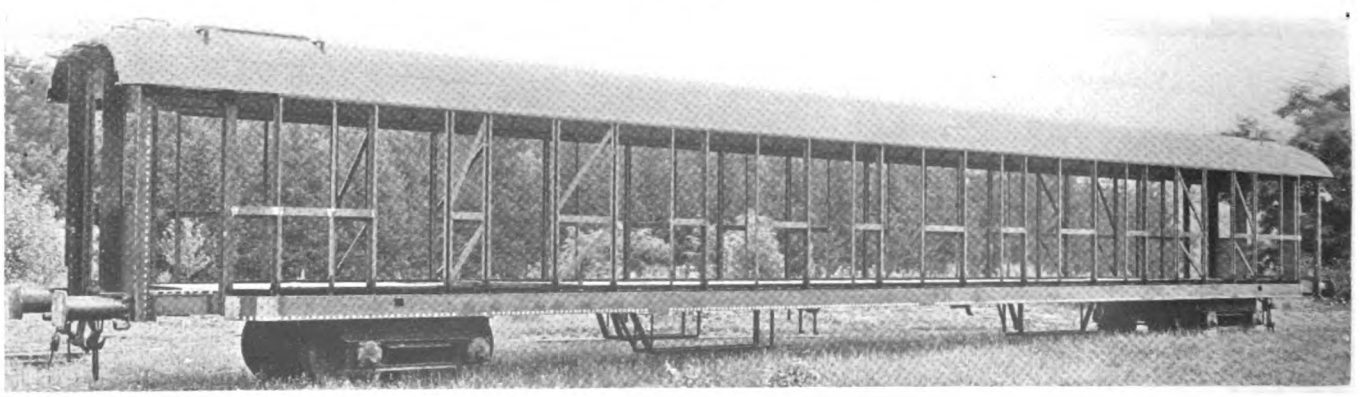
* * *

Equipment Depreciation Orders

THE Interstate Commerce Commission recently issued another series of sub-orders and modifications of previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies, prescribing equipment depreciation rates for 11 railroads, including the Atchison, Topeka & Santa Fe and the Pittsburgh & Lake Erie. The composite percentages, which are not prescribed rates, range from 3.34 per cent for the Washington Terminal to 10.2 for the Atlantic & Western.

The Santa Fe's composite percentage of 3.77 is derived from the following prescribed rates: Steam locomotives, 3.52 per cent; Diesel road locomotives, 6.33 per cent; Diesel switching locomotives, 4.75 per cent; refrigerator and ice cars, 4.75 per cent; other freight-train cars (wood underframe), 4.41 per cent; other freight-train cars (steel and steel underframe), 3.59 per cent; stainless steel lightweight passenger-train cars, 3.89 per cent; other passenger-train cars, 2.9 per cent; floating equipment, 2.87 per cent; work equipment, 4.8 per cent; miscellaneous equipment, 12.6 per cent. The 3.66 composite percentage for the Pittsburgh & Lake Erie is derived from the following prescribed rates: Steam locomotives, 3.8 per cent; freight-train cars,

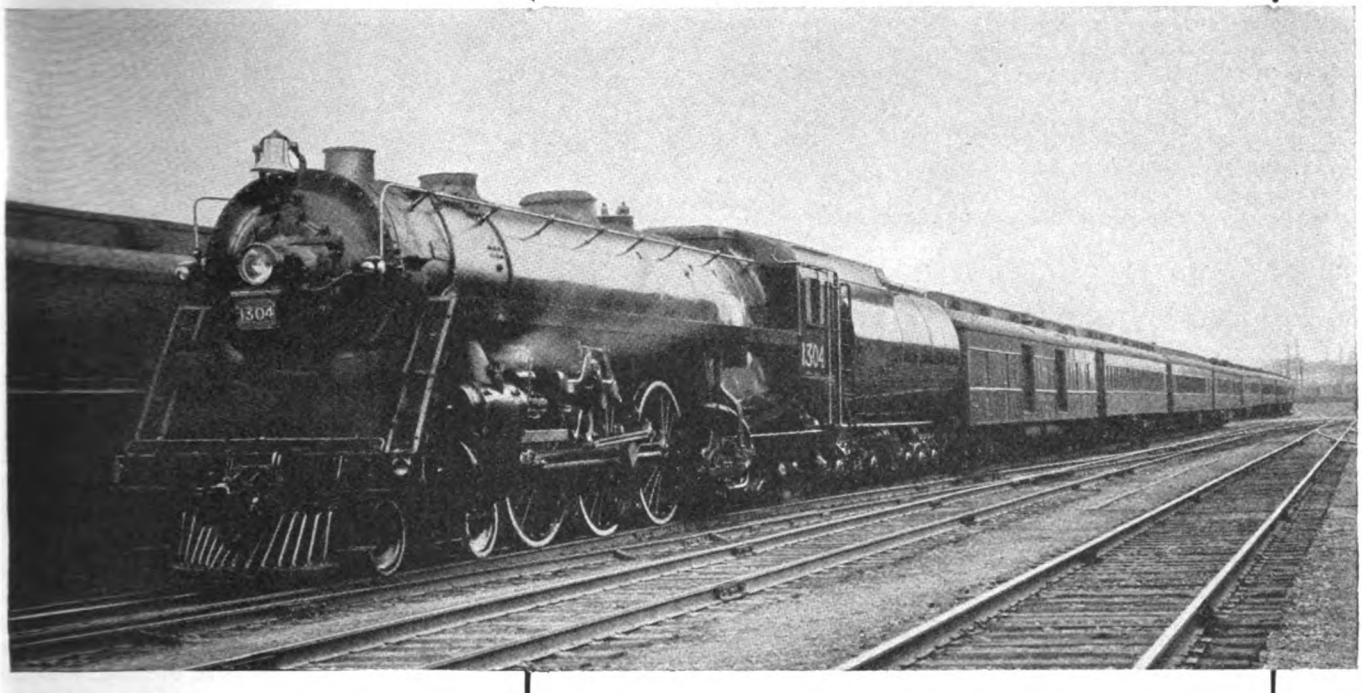
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Steel frame construction of modern Mitropa cars

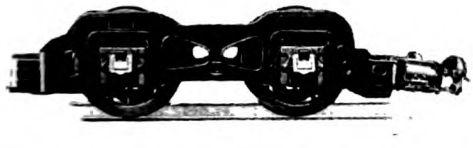
The structures are of the stressed skin type—Length over buffers, 77 ft. 1 in.; width overall, 9 ft. 4¾ in.; distance between truck centers, 53 ft. 1 in.—Service weights: First- and second-class sleeping car (22 berths), 117,500 lb.; third-class sleeper (3 berths each in 13 compartments), 117,700 lb.; dining car, 112,400 lb.

MODERN POWER



. . . is Balanced Power

The trend of Modern Locomotive design is definitely towards minimum weight on drivers, reduced dynamic augment, high starting and accelerating power and high horsepower capacity at high road speeds. »» To meet these objectives the high horsepower required in the operating range of speed is provided by the main cylinders and the additional tractive effort required for starting and rapid acceleration to road speeds is provided by the Booster. »» Such a locomotive, operating at the high speeds and high capacities of modern railroading, insures lower track maintenance costs, increased economies of operation and maintenance and greater net returns from every train it hauls.



All replacement parts furnished by Franklin Railway Supply Company are identical as to materials, design, clearances and workmanship with the parts they replace. They guarantee the same unfailing reliability of service.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

3.68 per cent; passenger-train cars, 3 per cent; work equipment, 3.46 per cent; miscellaneous equipment, 18.26 per cent.

Stainless Steel Exhibit in New York Museum

AN exposition of stainless steel has opened for a period of several months in the New York Museum of Science & Industry, Rockefeller Center, New York. The exhibit, which is sponsored jointly by the Electro Metallurgical Company, Unit of Union Carbide & Carbon Corp., New York, and the museum, portrays the history, development, production, fabrication and uses of stainless steel products. Among the many fields of application receiving emphasis is that of transportation equipment.

In this connection, the "Shotweld" system of joining stainless steel in the manufacture of railroad rolling-stock is demonstrated by special operators, and sections of car structures are placed for inspection.

New Equipment Orders and Inquiries Announced Since the Closing of the December Issue

Locomotive Orders

Road	No. of locos.	Type of loco.	Builder
Mexican Ry. Co.	3*	4-6-2	Montreal Locomotive Works
White Pass & Yukon	1	2-8-2	Baldwin Locomotive Works

Locomotive Inquiries

Road	No. of locos.	Type of loco.	Builder
Canadian National	6	4-8-4†	.....
Chesapeake & Ohio	14	18,000-gal. tenders	.....
Norfolk Southern	5	2-8-4	.....

Freight-Car Orders

Road	No. of cars	Type of car	Builder
Louisiana & Arkansas	275	70-ton flat‡	American Car & Foundry Co.

Freight-Car Inquiries

Road	No. of cars	Type of car	Builder
Canadian National	2,000	Box	.....
Western Maryland	500	50-ton box	.....
	100	50-ton gondolas	.....
Western Pacific	500	50-ton hopper	.....
	250	50-ton box	.....
	100	50-ton flat	.....
	50	50-ton gondola	.....

Passenger-Car Inquiries

Road	No. of cars	Type of car	Builder
Canadian National	5	Mail and express	.....

* These locomotives will have 20-in. by 28-in. cylinders, 69-in. driving wheels and will weigh 250,000 lb. in working order.
† 6400 type, for service on the Grand Trunk Western.
‡ For handling pulp wood.

Supply Trade Notes

CHARLES B. COLLINS, assistant vice-president of the American Car & Foundry Co., at St. Louis, Mo., has resigned.

A. E. BIDDLE, vice-president of the Cardwell-Westinghouse Company, Chicago, has been elected executive vice-president, and J. M. Hall, chief engineer, has been elected vice-president.

SAMUEL F. PRYOR, JR., has been appointed assistant to the president of the American Brake Shoe & Foundry Co. Mr. Pryor is also vice-president of the Southern Wheel Division of this company, with headquarters at New York. He is a director of many industrial organizations, including the National Bearing Metals Corporation, and is director and chairman of the executive committee of the Vanadium Corporation of America. Mr. Pryor is 39 years old and has been associated with the American Brake Shoe & Foundry Co., Southern Wheel Division, since 1924, serving as molder's helper, molder, and assistant superintendent. He entered the sales department of the company in 1927 and was elected vice-president in 1930. The American Brake Shoe & Foundry Co. consists of The American Brakeblok Division, Southern Wheel Division, Ramapo Ajax Division, American Manganese Steel Division, and its affiliate, The National Bearing Metals Corporation.



Greystone Studios, Inc.
Samuel F. Pryor, Jr.

E. T. SCHROEDER, 1205 Syndicate Trust building, St. Louis, Mo., has been appointed sales representative, in that territory, for the Hennessy Lubricator Company, 75 West street, New York.

BARD BROWNE, assistant to vice-president and N. T. McKee, general service manager of the Superheater Company, New York, have been elected vice-presidents, with headquarters, as heretofore, at New York.

B. C. WILKERSON, chief service engineer of The Superheater Company, has been appointed service manager, with headquarters at New York. During 1935 Mr. Wilkerson was in charge of the New England territory and on January 1, 1936, was appointed chief service engineer.

THE TRANE COMPANY, LaCrosse, Wis., has established a transportation department at 852 North Rush street, Chicago. J. Whalen of the Chicago branch and J. Hicks of the LaCrosse air-conditioning department have been transferred to the new department.

PHIL HUBER, vice-president and assistant general manager of the Ex-Cell-O Corporation, Detroit, Mich., and one of its organizers in 1919, has been elected president and general manager to succeed N. A. Woodworth, who has resigned because of ill health.

T. M. ROBIE, who has been in charge of Diesel sales to resale manufacturers for Fairbanks, Morse & Company, has been appointed manager of the Diesel sales division at Chicago.

MURRAY B. WILSON of the Detroit sales district office of the American Rolling Mill Company, Middletown, Ohio, has been appointed manager of the New York sales district, to succeed Cliff Spear, who has been forced to curtail his activities because of ill health.

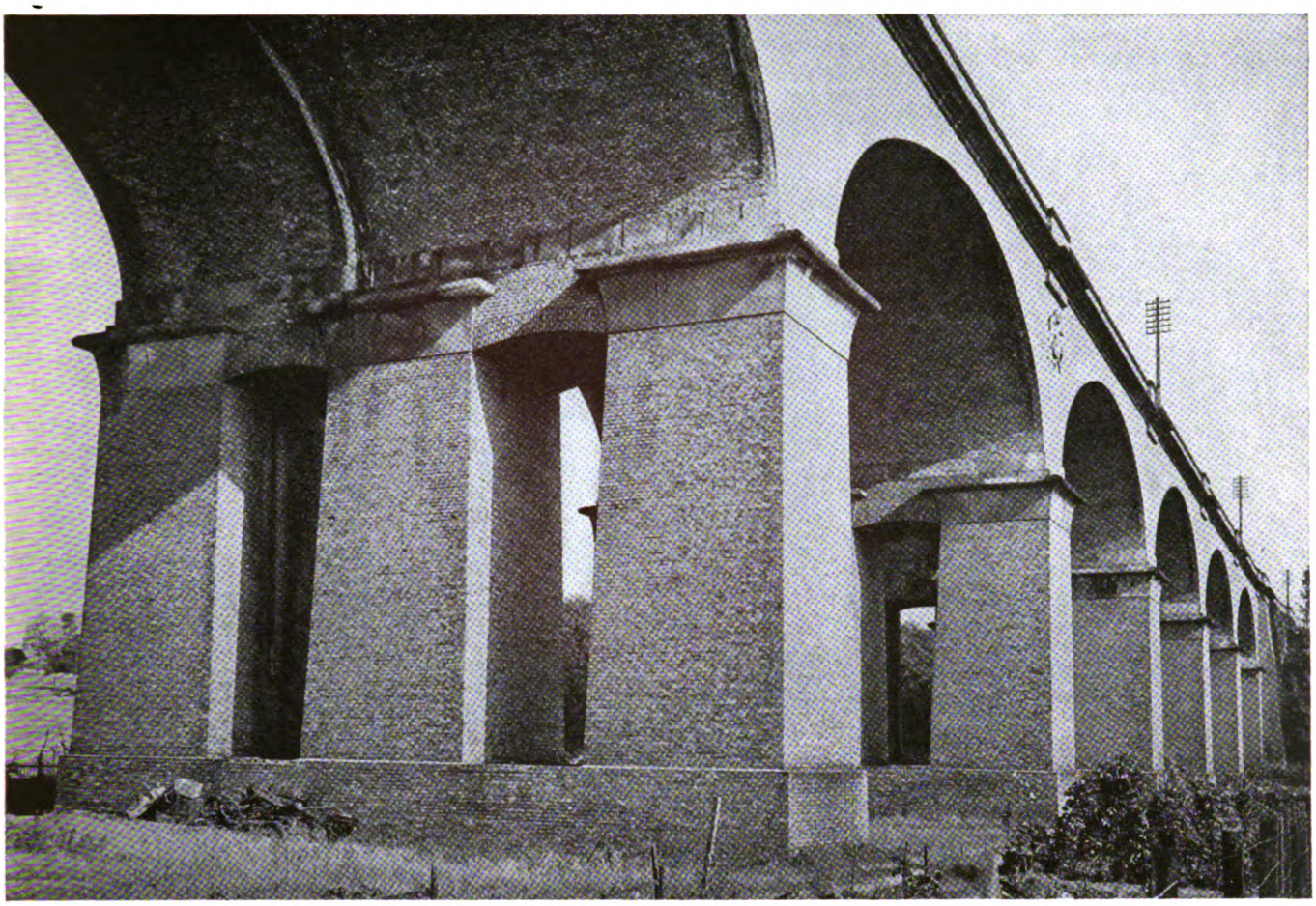
JOHN F. MACENULTY, vice-president in charge of sales of the Pressed Steel Car Company, Inc., Pittsburgh, Pa., was elected president and a member of the board of directors, and George H. Fleming, who had served as director and vice-president in charge of the Pittsburgh office, was elected executive vice-president, at a recent meeting of the board. Mr. MacEnulty began work with the Pressed Steel Car Company in February, 1899. He was appointed engineer of construction in 1903, and the following year was transferred to the New York sales department. In 1907 he was appointed general superintendent of the Western Steel Car & Foundry Co., a sub-



John F. MacEnulty

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NO. 10 OF A SERIES OF FAMOUS ARCHES OF THE WORLD



WHARNCLIFFE VIADUCT

HANWELL, ENGLAND

The Wharncliffe Viaduct on the route of the Great Western Railway at Hanwell, England, consists of eight semi-elliptical brick arches of 70 feet span springing from stone-capped piers. The base area of these piers is 252 square feet. This Viaduct was constructed one hundred years ago, 1836-1837. It is 896 feet in length and 65 feet high. It was named after Lord Wharncliffe as a compliment to the Chairman of the House of Lords Committee which authorized the railroad. This viaduct, originally constructed for two lines of way, was widened to take four tracks in 1875.

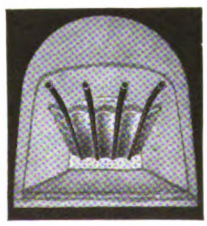
* * *

A complete Security Brick Arch in the locomotive firebox is essential to full fuel economy. To facilitate locomotive arch maintenance, the American Arch Company maintains an adequate stock of Security Arch Brick at conveniently located points throughout the country.

THERE'S MORE TO SECURITY ARCHES THAN JUST BRICK

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

sidiary of the Pressed Steel Car Company, and two years later, was appointed general manager of the same company. In June, 1912, Mr. MacEnulty was appointed sales manager of the Pressed Steel Car Company and subsidiaries, and from January, 1916, served as vice-president and a director until the company's recent reorganization, when he became vice-president in charge of sales of the Pressed Steel Car Company, Inc.

THE ECLIPSE AIR BRUSH COMPANY, INC., has removed its office and factory to 390 Park Avenue, Newark, N. J., the building formerly occupied by the company having been damaged by fire on December 14.

THE WATSON-STILLMAN COMPANY, Roselle, N. J., has transferred its district sales office from Columbus, Ohio, to Detroit, Mich. J. C. Grindlay, western sales manager, is in charge of the new office, which is located in the Book building.

W. E. WECHTER, assistant manager of the Oil & Gas Engine division of the Worthington Pump and Machinery Corporation, at Harrison, N. J., has been appointed manager of oil & gas engine sales, Atlantic division, to succeed R. L. Howes, resigned. Mr. Wechter now has his headquarters at 2 Park avenue, New York City.

CHARLES T. RIPLEY, former chief mechanical engineer of the Atchison, Topeka & Santa Fe, has been appointed chief engineer of the newly organized Technical Board of the Wrought Steel Wheel Industry, which has its office in the South Michigan building, Chicago. This organization was formed by the American Rolling Mill Company, the Bethlehem Steel Company, the Carnegie-Illinois Steel Corporation, the Edgewater Steel Company and the Standard Steel Works Company. The purpose of the board is to make an organized and co-ordinated attack on the technical problems presented by the increasingly difficult requirements of railroad service, to collect full information regarding the performance of wheels and to establish channels of communication and co-operation between the wrought-steel-wheel manufacturers and the railroads on engineering problems.

J. H. VAN MOSS, who has been appointed western sales manager of the American Car and Foundry Co., with headquarters at Chicago, as noted in the December issue of the *Railway Mechanical Engineer,* was for many years connected with various railroads. In 1918 he served as eastern sales representative for the Pennsylvania Tank Car Company and the Pennsylvania Tank Line. During the period from 1918 to 1927 he gained promotion to the vice-presidency of both companies. Subsequently he was elected to the presidency of the Pennsylvania Tank Car Company, meanwhile retaining the vice-presidency of the Pennsylvania Tank Line. Early in 1927 he entered the service of the Shippers Car Line Corporation, subsidiary of the American Car and Foundry Co., and in October, 1934, became associated with the parent company as sales agent. In December, 1936, he was appointed assistant vice-president of the American Car and Foundry Co.

ERNEST P. WAUD, vice-president of the Griffin Wheel Company, Chicago, has been elected president, to succeed Frank L. Whitcomb, who has been elected vice-chairman of the board of directors. Mr.



Ernest P. Waud

Waud was educated at St. Paul's school, Garden City, Long Island, N. Y., and Cornell University. He entered the employ of the Griffin Wheel Company in 1905 as inspector of chilled railroad car wheels and was later appointed chief inspector, department manager and assistant treasurer. In 1919 he was elected a vice-president, which position he has held until his recent election. Mr. Whitcomb has been associated with the Griffin Wheel Company since 1889. He was elected president in 1913, succeeding Thomas A. Griffin, who was the founder and first president of the company.

J. BROOKES SPENCER, president of the Ramapo Ajax Corporation and vice-president of the Southern Wheel Division of The American Brake Shoe & Foundry Co.,



(c) Bachrach

J. Brookes Spencer

has been elected vice-president of The American Brake Shoe & Foundry Co., with headquarters at New York. Mr. Spencer was born on January 15, 1888, at St. Louis, Mo., and was graduated from Yale University in 1910. He entered the employ of the Southern Wheel Company, a subsidiary of The American Brake Shoe & Foundry Co., in 1917, and a year later became assistant to the vice-president of that company. Mr. Spencer was elected vice-president of the Southern Wheel Company in 1921, and in February, 1936, was elected president of the Ramapo Ajax Corporation, with headquarters at New York.

THE JONES & LAUGHLIN STEEL CORPORATION now has in operation the first continuous mill in Pittsburgh for the manufacture of wide steel strip and sheets and steel plates. When operating at full capacity this new mill will provide employment for 1,200 additional men. Some of the products of the mill will have railroad uses, particularly in car construction. Its annual capacity is three-quarters of a million tons. The mill, costing $25,000,000, covers twenty-three acres, extending for half a mile along the Monongahela River.

Obituary

CHARLES GILBERT, vice-president and treasurer of the Scullin Steel Company, St. Louis, Mo., died on December 1 of a heart ailment.

EUGENE J. BUFFINGTON, who retired as president of the Illinois Steel Company, Chicago, in 1932, died in that city on December 9, following an operation.

STANLEY T. SCOFIELD, assistant to vice-president of the United States Steel Corporation, died of polyneuritis in the Presbyterian hospital, Chicago, on November 30, at the age of 51 years.

FRANK B. BLACK, chairman of the board of directors and founder of The Ohio Brass Company, Mansfield, Ohio, died suddenly of a heart attack at his home on December 19. He was 72 years old.

OVERTON BERNARD CAPPS, district sales manager of The Standard Stoker Company, Inc., with headquarters at Baltimore, Md., died on December 4, at the age of 57 years in the Protestant Hospital, Norfolk, Va., after an illness of six months. Mr. Capps began his business career in 1899, with the American Locomotive Company at Richmond, Va. From 1910 until the time of his death, he was actively engaged in sales work with the Locomotive Stoker Company and The Standard Stoker Company, Inc.

W. W. ROSSER, president of the Railway Truck Corporation, Chicago, died of pneumonia on December 22. Mr. Rosser was born in Hutchinson, Minn., on November 4, 1877, and attended Hamline University. He entered the employ of the Northern Malleable Iron Company, St. Paul, Minn., in 1901 and served the Washburn Company, Chicago, from 1903 to 1905. He then entered the employ of the T. H. Symington Company, of which company he was vice-president from 1915 to 1919. From the latter year until 1930 he was vice-president of the Bradford Corporation. In November, 1937, he became president of the Railway Truck Corporation.

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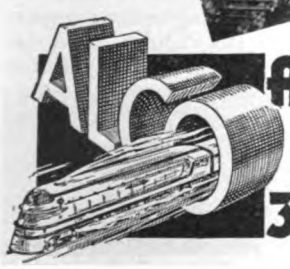
WHAT PRICE *Quality?*



THE manufacture of high quality light-weight alloy steel forgings, as of any other high quality product, involves certain fixed costs. If these costs are reduced beyond a certain point, the product ceases to be "exactly right" and cannot deliver the proper dependable service.

More than a century's experience in locomotive construction has taught the American Locomotive Company how to reduce these manufacturing costs to the safest possible minimum and yet meet the severest service requirements.

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AMERICAN LOCOMOTIVE COMPANY

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Personal Mention

General

JAMES PAUL, who has retired as general superintendent motive power of the Atlantic Coast Line, was born in Lanarkshire, Scotland. He entered railroad



James Paul

service in 1885 with a predecessor of the Atlantic Coast Line as a car inspector helper. Later he was transferred to the machine shop as an apprentice. Mr. Paul subsequently served as air-brake repairman, enginehouse foreman and then as general foreman. In 1906 he became master mechanic; in November, 1925, assistant superintendent of motive power, and in March, 1927, superintendent of motive power. He became general superintendent of motive power with headquarters at Wilmington, N. C., in August, 1929, but for the past year, had been absent from his office, due to ill heaith.

G. C. CHRISTY, who has been appointed superintendent of motive power of the Illinois Central at Chicago, as noted in the December issue of the *Railway Mechanical Engineer,* has had a record of more than 39 years of experience with the



G. C. Christy

Illinois Central, with which road he took his first position on June 1, 1898, as a painter apprentice at Water Valley, Miss. At the end of two years he was transferred to the machine shop as a machinist apprentice. During the ensuing years Mr. Christy was advanced through various positions in the machine shop until October, 1911, when he became general foreman. In December, 1914, he was transferred to McComb, Miss., where he remained until July, 1917, when he was promoted to master mechanic, with headquarters at Vicksburg, Miss. From November 1, 1929, until his appointment as superintendent of motive power, he was superintendent of the car department, with headquarters at Chicago.

K. F. NYSTROM, who has been appointed mechanical assistant to the chief operating officer of the Chicago, Milwaukee, St. Paul & Pacific, as noted in the December issue, was born in Sweden in September, 1881, and was educated as a mechanical engineer at a Swedish university. Coming to the United States in 1905, he entered the service of the Pressed Steel Car Company as a draftsman, serving with this company until 1909, when he joined the



Karl F. Nystrom

engineering staff of the Pullman Company. After a short period of service with the latter company he became connected with the Southern Pacific in the car design department. In 1911 he became assistant mechanical engineer of the American Car & Foundry Company. Shortly thereafter he became mechanical engineer of the Acme Supply Company, and in 1913 became chief draftsman in the car department of the Grand Trunk (now part of the Canadian National). From 1918 to 1920 he served as chief draftsman in the car department of the Canadian Pacific, returning to the Grand Trunk at the end of this period as engineer of car construction. In 1922 he entered the service of the Milwaukee as engineer of car design, being appointed engineer of motive power and rolling stock in 1925. For a few months in 1927 Mr. Nystrom served as master car builder of the Milwaukee, then being appointed superintendent of the car department. As mechanical assistant to the chief operating officer, Mr. Nystrom will continue to have general supervision over the car department and, in addition, will supervise engineering, designing, construction and coordination of facilities in the mechanical department. Mr. Nystrom is president of the Car Department Officers Association.

OTTO JABELMANN, who has been appointed to the newly created position of assistant to the president in charge of research of the Union Pacific, is a



Otto Jabelmann

native of Cheyenne, Wyo., Mr. Jabelmann started service with the Union Pacific in 1906 at the age of 16 as a caller in the enginehouse at that point. He has been in the service of this company continuously since that time, with the exception of three years during which period he attended the University of Michigan. Advancing through various positions in the mechanical department, Mr. Jabelmann was appointed superintendent of shops of the Union Pacific Railroad in 1925. Eight years later he was promoted to assistant general superintendent of motive power and machinery of the system, which position he was holding in 1936, when, with the same title, he was placed in charge of the Union Pacific's newly established research bureau. Work that has been carried out under the supervision of Mr. Jabelmann includes the design of this company's various streamliners, the turbine-electric locomotive which is now nearing completion, the new 5,400-hp. Diesel-electric locomotives, the lightweight Challenger trains, lightweight freight cars, new lighting and air-conditioning methods, etc.

LEE ROBINSON, who has been appointed superintendent of equipment of the Illinois Central at Chicago, as announced in the December issue of the *Railway Mechanical Engineer,* was born in Clay Center, Kan., and after a public school education in Kansas City, served as an assistant instructor in manual training. Subsequently he left educational work to become a draftsman with a firm of consulting bridge engineers in Kansas City. His railroad career began as a draftsman and special apprentice with the Kansas City Southern at Pittsburg, Kan. Later he served three years in the mechanical department of the Missouri Pacific at St. Louis, Mo., and three

(*Continued on next left-hand page*)

The BARBER
Lateral Motion Device

High Carbon Steel Rollers



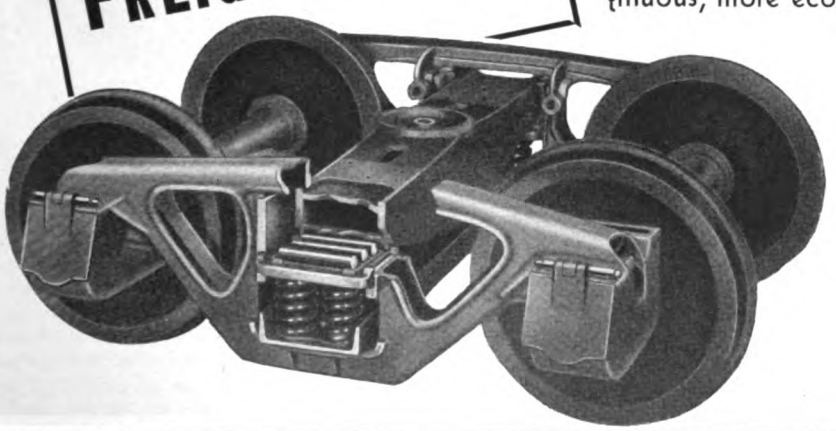
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THE Barber Lateral Motion Device is the *only* practical device providing lateral motion without the use of dangerous wearing parts found in conventional "swing hanger" trucks.

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Truck Cut Away Showing Lateral Motion Device in Position

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years with the St. Louis-San Francisco at Springfield, Mo. He entered the service of the Illinois Central in charge of general engineering work connected with the maintenance and design of locomotives and



Lee Robinson

cars, subsequently holding the positions of mechanical valuation engineer and shop engineer. On March 10, 1930, he was appointed to the position of assistant to the general superintendent of motive power at Chicago, which he was holding at the time of his recent promotion to superintendent of equipment. Mr. Robinson was president of the Western Railway Club for the year 1935-36.

THOMAS H. DUFFY has been appointed assistant fuel service engineer of the Chesapeake & Ohio, with headquarters at Richmond, Va.

T. C. BALDWIN has been appointed superintendent of motive power of the New York, Chicago & St. Louis, with headquarters at Cleveland, Ohio, succeeding J. J. Maginn, deceased.

EMIL VON BERGEN, general air-brake, steam-heat and lubrication engineer of the Illinois Central, has been appointed to the newly created position of assistant to the vice-president and general manager—research, with headquarters as before at Chicago. In his new position, Mr. Von Bergen will make observations and studies with the view of accomplishing economies and improvements in the various phases of the company's operations.

Master Mechanics and Road Foremen

FRANK J. TOPPING, general foreman of the Hinton (W. Va.) locomotive shops of the Chesapeake & Ohio, has been promoted to the position of assistant master mechanic, Hinton division.

JOHN D. DAVENPORT, master mechanic of the Hinton division of the Chesapeake & Ohio, with headquarters at Hinton, W. Va., has been appointed master mechanic in charge of the Hinton and Clifton Forge divisions.

G. H. NOWELL, who has been appointed district master mechanic of the Canadian Pacific at Vancouver, B. C., as noted in the November issue of the *Railway Mechanical Engineer,* was born on November 13, 1884, at Montreal, Que. He entered the service of the Canadian Pacific on July 2, 1899, as a machinist apprentice at Montreal, and completed his apprenticeship on July 2, 1904. On January 15, 1913, Mr. Nowell was promoted to the position of erecting shop foreman at Ogden, Alta. He became locomotive foreman, with headquarters at Cranbrook, on September 4, 1915; division master mechanic on December 5, 1915, with headquarters at Nelson, B. C., also at Revelstoke, B. C., Lethbridge, Alta., and Regina, Sask. He was appointed district master mechanic at Moose Jaw, Sask., on July 1, 1936, and district master mechanic at Vancouver, on October 16, 1937.



G. H. Nowell

T. C. SHORTT has been appointed master mechanic of the Nickel Plate district of the New York, Chicago & St. Louis, with headquarters at Conneaut, Ohio. Mr. Shortt's former position of assistant to superintendent motive power has been abolished.

Car Department

JOSEPH A. DEPPE, who has been appointed superintendent of the car department of the Chicago, Milwaukee, St. Paul & Pacific, has been associated with the Milwaukee for more than 35 years. He entered the service of this company in April, 1902, as a helper, later serving as an inspector, billing clerk, and chief clerk to master car builder. In March, 1918, he became assistant to master car builder and two years later became general superintendent of the freight-car-shop department. In December, 1920, Mr. Deppe was promoted to the position of assistant master car builder and in August, 1927, was appointed assistant superintendent of the car department, with headquarters at Chicago.



Joseph A. Deppe

P. P. BARTHELEMY, assistant master car builder of the Great Northern, has been promoted to master car builder, with headquarters as before at St. Paul, Minn., to succeed C. H. Putnam, who has retired.

R. KNORR, shop superintendent of the Erie at Susquehanna, Pa., has been appointed supervisor of car repairs of the Western district, with headquarters at Cleveland, Ohio, to succeed C. Rhodes.

C. RHODES, supervisor of car repairs of the Western district of the Erie at Cleveland, Ohio, has been transferred to the Eastern district with headquarters at Cleveland, to replace W. H. Middaugh, supervisor of car repairs at Port Jervis, N. Y., who has been transferred to other duties.

Shop and Enginehouse

J. F. MCMULLEN, division car foreman at Buffalo, N. Y., has been appointed shop superintendent of the Erie, with headquarters at Susquehanna, Pa., to succeed R. Knorr.

Purchasing and Stores

JOHN J. CONN, assistant general purchasing agent of the Atchison, Topeka & Santa Fe System, with headquarters at Chicago, has been appointed general purchasing agent, to succeed Michael J. Collins, deceased. Mr. Conn has been in the service of the Santa Fe continuously for nearly 39 years. He was born on February 13, 1874, at Chicago, and graduated in 1889 from St. Patrick's Commercial Academy. He entered the service of the Santa Fe in February, 1899, as an office boy in the purchasing department, where he later served in various clerical capacities. In January, 1907, Mr. Conn was promoted to chief clerk in the same department and about three years later became assistant general purchasing agent.



Moffett

John J. Conn

RAILWAY MECHANICAL ENGINEER

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.



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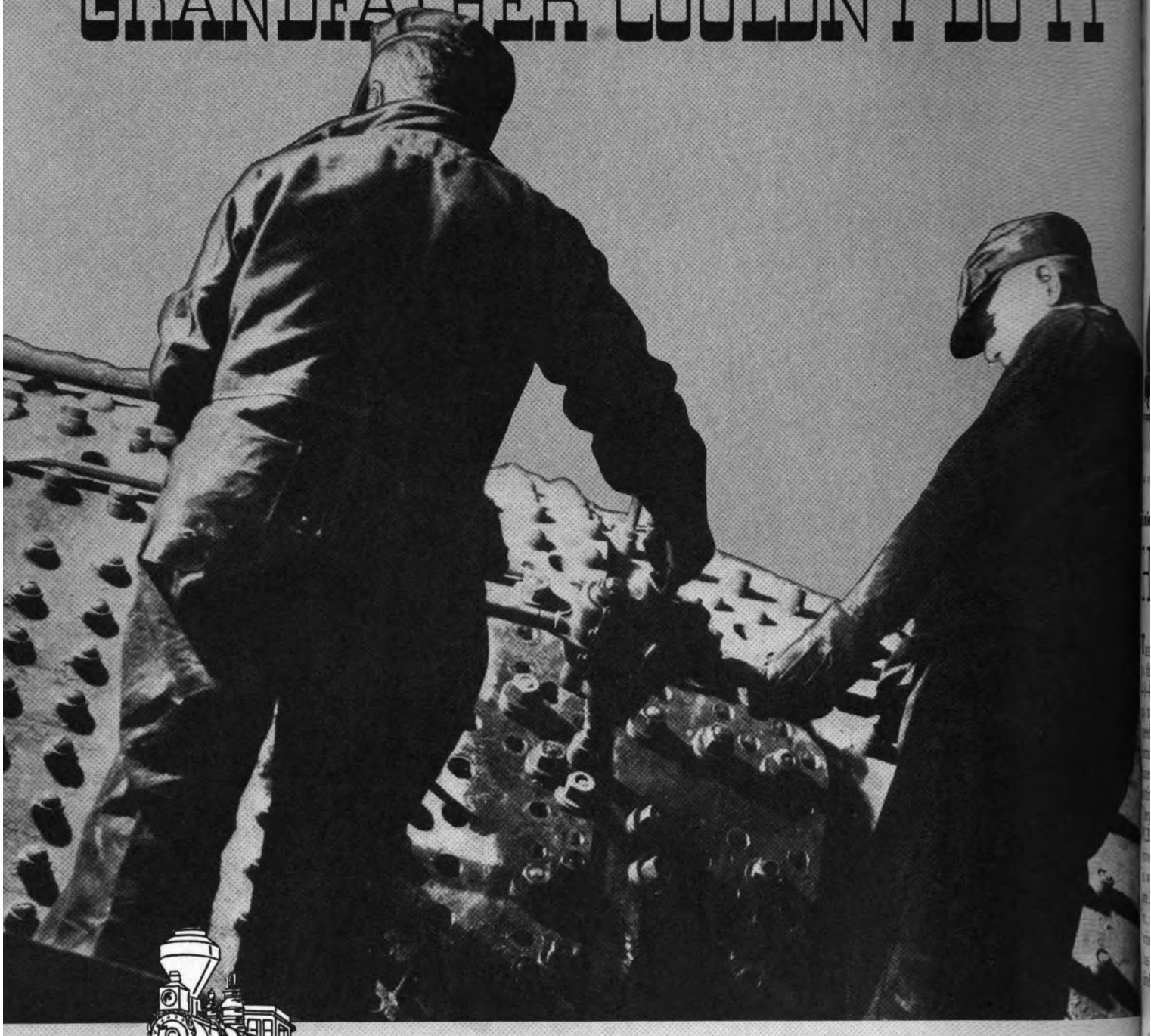
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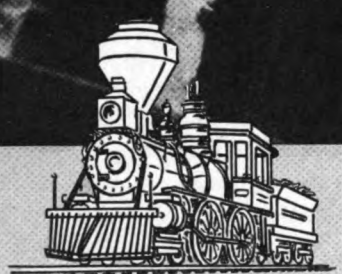
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GRANDFATHER COULDN'T DO IT





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One of the Union Pacific 4-8-4 passenger locomotives

Union Pacific

Heavy Passenger Locomotives

American builds 4-8-4 type which weighs 465,000 lb. and develops 63,600 lb. tractive force—Unusual features include cab supported entirely on the boiler and side rods without the usual knuckle joints at the intermediate-rod connections

THE American Locomotive Company recently delivered to the Union Pacific 20 passenger locomotives of the 4-8-4 type which were designed throughout for speeds up to 90 m.p.h. They are being run at average road speeds of 60 m.p.h. and have given satisfactory performance at speeds in excess of 100 m.p.h., maintained in several instances on down grades. These locomotives develop a starting tractive force of 63,600 lb. They have a total engine weight of 465,000 lb., of which 81,200 lb. is on the engine truck, 270,000 lb. on the drivers and 113,800 lb. on the trailing truck. The tender in working order weighs 366,500 lb. The driving wheels are 77 in. in diameter; the cylinders are 24½ in. by 32 in., and the overall length is 110 ft. 7⅛ in. The boiler, which carries a working pressure of 300 lb. per sq. in., has a combined heating surface of 6,070 sq.ft. and the firebox has a grate area of 100.2 sq.ft.

Frames and Running Gear

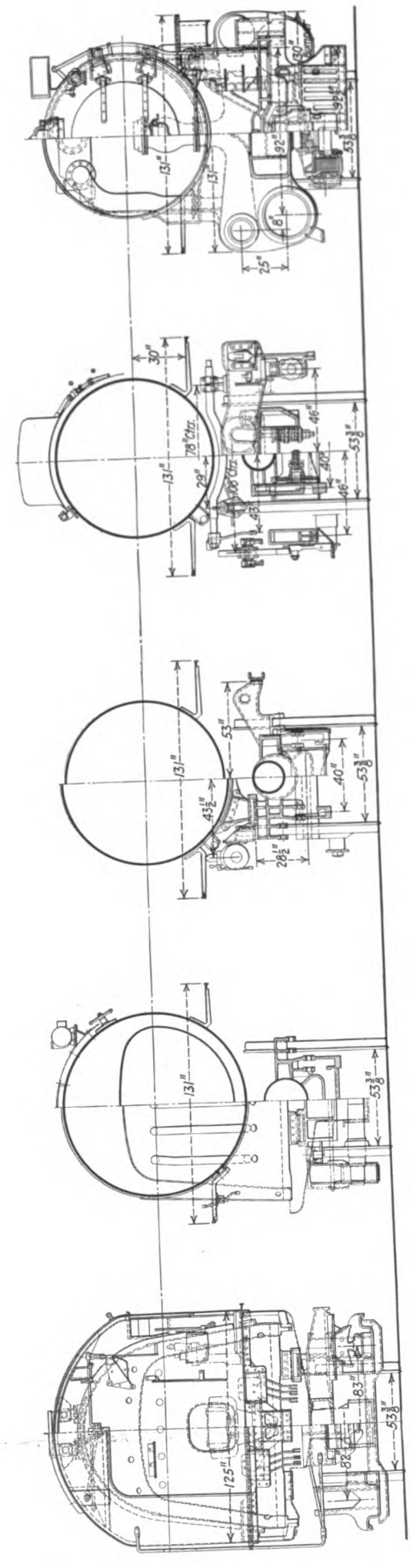
The frames are one-piece steel castings made by the General Steel Castings Corp., which include cylinders, back cylinder heads, main air reservoirs, supports for the air pumps, supports for the guides, and supports for the reverse gear brackets. The front bumper is a steel casting, separate from the body.

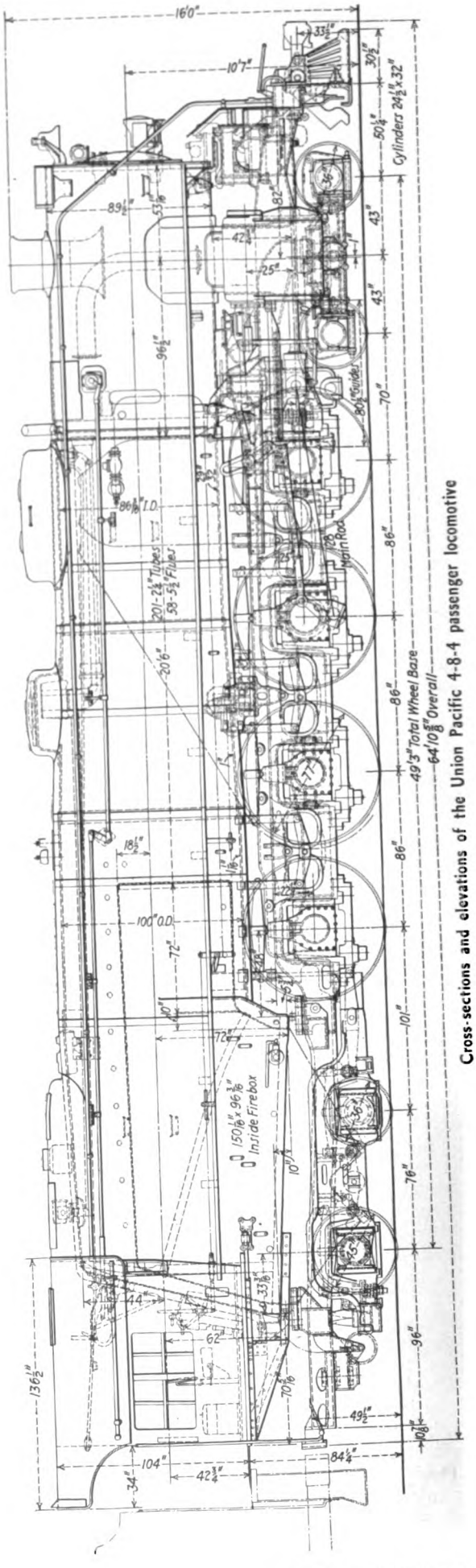
One of the outstanding features of these locomotives is the side-rod design, which is a development of the Union Pacific. As shown by the drawings, the side rods have no knuckle joints on the front and back sections. The rear end of the front side rod is $2\frac{3}{16}$ in. wide and is mounted between the jaws of the front end of the intermediate rod with $\frac{3}{16}$ in. total clearance. A brass bushing is pressed in the rear end of the front side rod and this runs on a steel bushing pressed in the jaws of the intermediate rod which, in turn, runs on the usual floating bushing on the pin. The back side rod is a duplicate of the front side rod, the front end being $2\frac{3}{16}$ in. wide, and fits between the jaws at the back end of the intermediate rod. The outer ends of the front and back side rods, as well as the back end of the main rod, are channeled to reduce weight to a minimum.

The driving wheels are of the Alco Boxpok type and are cross-counterbalanced on the main drivers only by auxiliary blocks set at right angles to the main counterbalance. The total reciprocating weight on each side is 2,060 lb. The over-balance per wheel on the front drivers is 213 lb.; on the intermediate drivers, 215 lb.; on the main drivers, 163 lb.; and on the back drivers, 207 lb. The dynamic augment at 90 m.p.h. on the front driver is 14,900 lb.; on the intermediate driver, 15,000 lb.; on the main driver, 11,400 lb., and on the back driver, 14,500 lb.

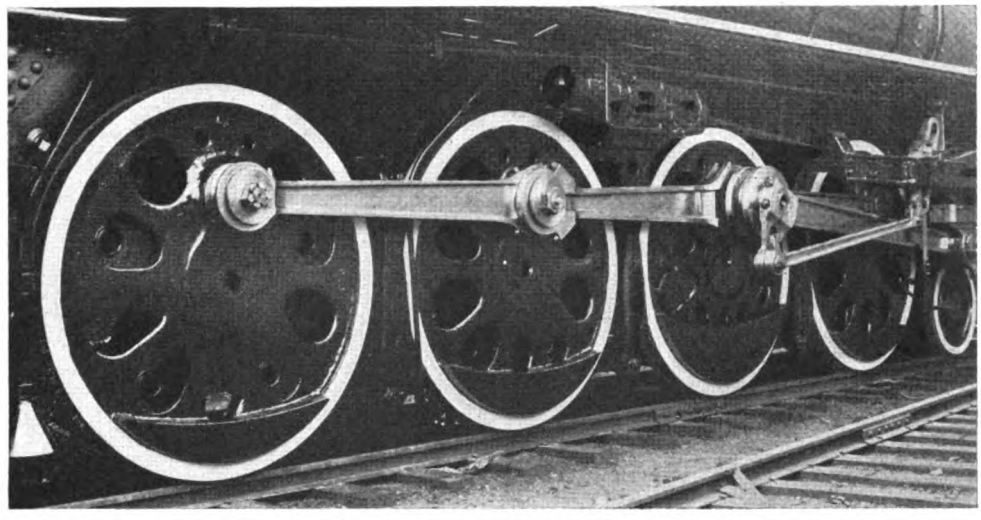
The driving boxes are fitted with Timken roller bearings and one-piece Timken bearing housings. The first and third drivers are equipped with Alco lateral cushioning devices. The driving axles are of low-carbon nickel steel, quenched and tempered, and have ground wheel fits and journals. The main drivers are hollow bored 4 in. and have 13¾-in. journals, while all the other axles are hollow bored 3½ in. and have 12⅝-in. journals. The engine-truck and trailer-truck axles are of medium carbon steel and also have ground journals. The front drivers have ⅝-in. lateral on each side; the main drivers have ¼-in. lateral on each side, and the Nos. 3 and 4 drivers have $\frac{3}{16}$-in. lateral on each side.

The spring suspension on each side is snubbed by two outer coil Class G springs set in tandem beneath a cross





Cross-sections and elevations of the Union Pacific 4-8-4 passenger locomotive



The front end of the back side rods and the back end of the front side rods are tongued to fit between the jaws of the intermediate sections and run directly on the crank pins, thus eliminating knuckle joints

equalizer located ahead of front driving-wheel axle, and by one outer coil Class G spring on the lower end of the hanger at the rear end of the trailing truck.

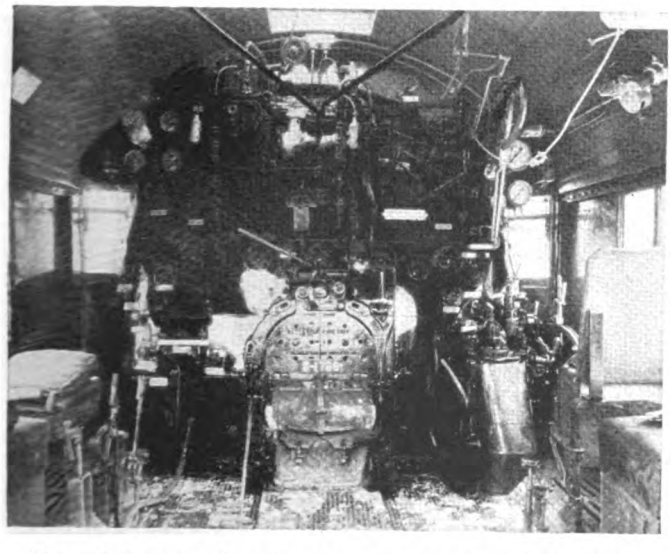
The valve gear is of conventional Walschaert design. The Franklin Ragonnet Type E reversing gear, with a 10-in. cylinder, is used on 15 engines, while the remaining five engines are equipped with Alco Type G reverse gear. The engines are designed to operate at 80.8 per cent cut-off.

The guides and crossheads are of multiple ledge design and are surfaced with pure tin. The main rods, side rods and crank pins are of low-carbon nickel steel, quenched and tempered. The crosshead pin is of medium-carbon steel and is ground. The piston rods are of low-carbon nickel steel and have ground tapered fits.

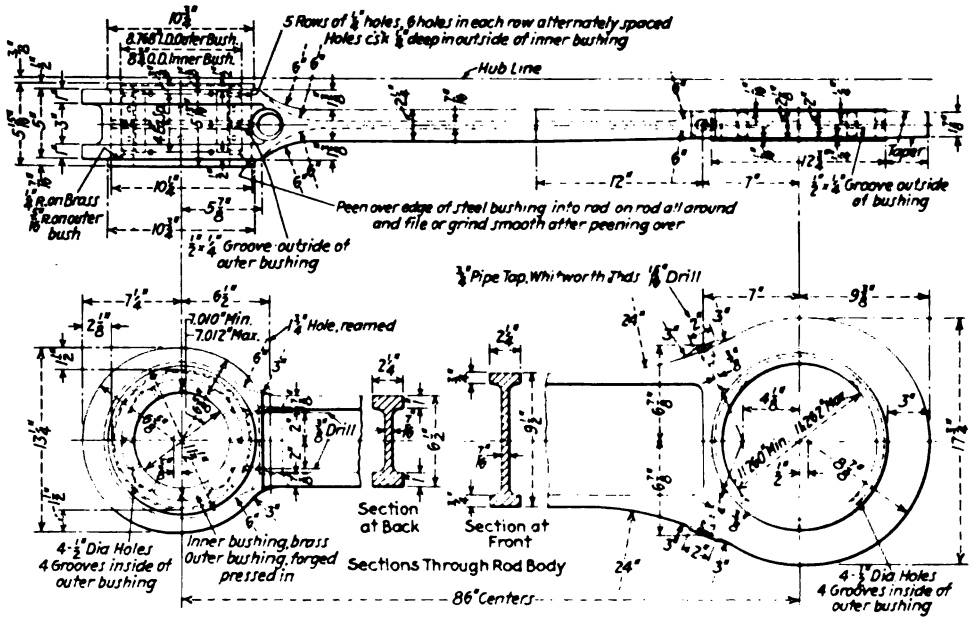
The pistons are of solid rolled steel in Z-section, fitted with the Locomotive Finished Material Company's com-

General Dimensions, Weights and Proportions of the Union Pacific 4-8-4 Type Locomotives

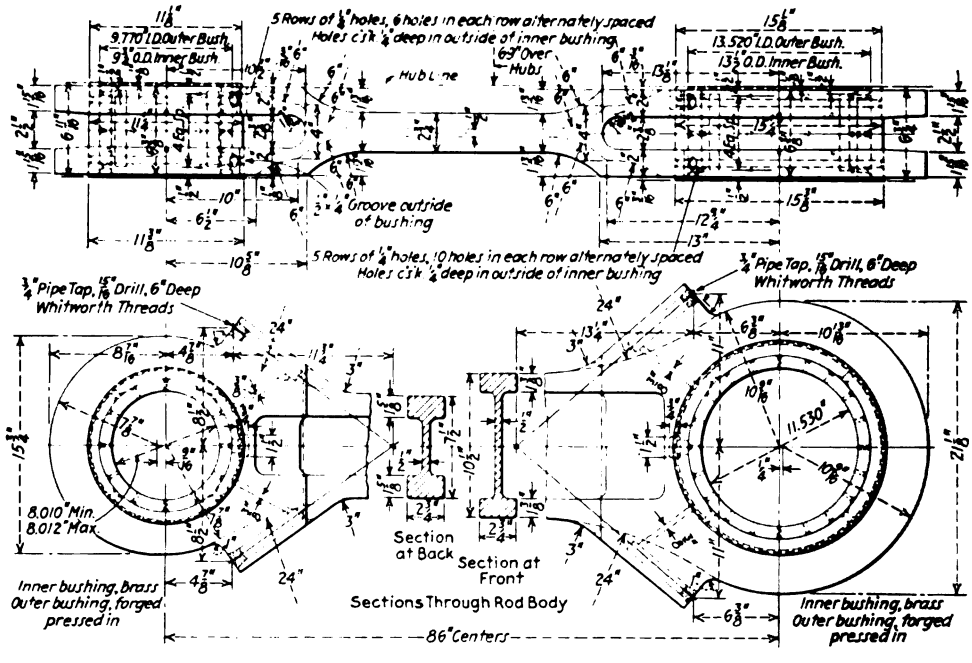
Railroad	Union Pacific
Builder	American Locomotive Co.
Type of locomotive	4-8-4
Road number	800-819
Date built	July-September, 1937
Dimensions:	
Height to top of stack, ft. and in.	16– 0
Height to center of boiler, ft. and in.	10– 7
Width overall, ft. and in.	10–11
Cylinder centers, in.	92
Weights in working order, lb.:	
On drivers	270,000
On front truck	81,200
On trailing truck	113,800
Total engine	465,000
Tender	366,500
Wheel bases, ft. and in.:	
Driving	21– 6
Total engine	49– 3
Engine and tender, total	97– 6
Wheels, diameter outside tires, in.:	
Driving	77
Front truck	36
Trailing truck (rear wheel)	45
Trailing truck (front wheel)	36
Engine:	
Cylinders, diameter and stroke, in.	24½×32
Valve gear	Walschaert type
Maximum travel, in.	7
Steam lap, in.	1⅜
Exhaust lap, in.	0¼
Lead, in.	0 6/16
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	300
Diameter, first ring, inside, in.	86 8/16
Diameter, largest, outside, in.	102⅛
Firebox length, in.	150 4/16
Firebox width, in.	96 8/16
Height, mud ring to crown sheet, back, in.	76
Height, mud ring to crown sheet, front, in.	90½
Combustion chamber length, in.	72
Tubes, number and diameter, in.	201– 2¼
Flues, number and diameter, in.	58– 5½
Length over tube sheets, ft. and in.	20– 6
Fuel	Soft coal
Stoker	Standard type BK
Grates, type	Firebar
Grate area, sq. ft.	100.2
Heating surfaces, sq. ft.:	
Firebox and combustion chamber	422
Arch tubes	57
Firebox total	479
Flues and tubes	4,118
Evaporative, total	4,597
Superheating	1,473
Combined evap. and superheat.	6,070
Tender:	
Style or type	U-shape
Water capacity, U. S. gal.	20,000
Fuel capacity, tons	25
Trucks	12-wheel
General data:	
Rated tractive force, engine, 85 per cent, lb.	63,600
Weight proportions:	
Weight on drivers ÷ weight of engine, per cent	58.00
Weight on drivers ÷ tractive force	4.25
Weight of engine ÷ combined heating surface.	76.5
Boiler proportions:	
Firebox heating surface, per cent of combined heating surface	7.9
Tube-flue heating surface, per cent of combined heating surface	67.8
Superheating surface, per cent of combined heating surface	24.3
Firebox heat. surface ÷ grate area	4.78
Superheat. surface ÷ grate area	14.7
Tube-flue surface ÷ grate area	41.1
Comb. heat. surface ÷ grate area	60.5
Tractive force ÷ grate area	635.0
Tractive force ÷ combined heating surface	10.5
Tractive force X diam. drivers ÷ combined heating surface	808.5



The cab interior—The cab is supported completely on the boiler



Details of the back section of the side rods



Details of the intermediate section of the side rods

bined bull ring and packing rings. The valve chambers are fitted with Hunt-Spiller bushings and the valves are of Hunt-Spiller lightweight design with duplex packing rings. Paxton-Mitchell packing is used on both valve stems and piston rods.

The locomotives have Alco four-wheel engine trucks with inside SKF roller bearings and cast-steel wheels. The trucks are equipped with lateral resistance of the geared roller type. These are built with a low initial resistance, gradually building up to a higher resistance which becomes constant after about 1 in. of lateral movement. The vertical damping device which is built into each side of the engine truck consists of fiber discs mounted on a horizontal spindle at each side of the truck frame. Between the fiber discs are two rotating metal plates, projecting from each of which is a tongue by which it is connected to the end of the bolster, by linkage. The links are on opposite sides of the spindle about which the plates rotate. Any vertical movement of the bolster with respect to the truck frame, therefore, causes the discs to rotate in opposite directions, a movement which is restrained by the adjustable friction load on the discs imposed by a coil spring on the horizontal spindle.

The trailer truck is of the Commonwealth four-wheel Delta type. The centering device on this truck is designed to produce an initial resistance of 8 per cent which builds up to a constant resistance of 16 per cent. The trailer-truck wheels are fitted with SKF roller-bearing journal boxes of the outside type. The rear trailer wheels which are 45 in. diameter have cast-steel centers, while the front wheels of 36 in. diameter are rolled steel, quenched and tempered.

The engines are equipped with 8½-in. air compressors and a main reservoir with a capacity of 91,000 cu. in. Clasp type brakes are used on the trailer-truck wheels, while the brakes on the drivers consist of a single brake-head design with double shoes. The braking ratios are 60 per cent on the drivers and 45 per cent on the trailer-truck wheels.

National spring washers of the heavy track type are used on guides and binders, smokebox front end, stack and extension, trailer pedestal binders, tender-truck pedestal binders, pipe clamps, running board and cap bolts, and pilot-beam bolts. A large proportion of the bolts

used in the locomotive—such as those used in the trailer-truck pedestal caps, smokebox ring, all finished tapered bolts, boiler studs, cylinder heads, steam-chest studs, eccentric-crank bolts, frame bolts, steam-pipe bolts and studs, exhaust pipe, reverse-gear bracket, exhaust-steam injector, air pumps and force-feed lubricator—are of nickel steel. Chrome-nickel steel is used for injector-check studs, main-rod-wedge bolts, engine-truck pedestal thimble bolts, front crank-pin collar bolts, guide bolts and pedestal cap bolts.

Lubrication

Each locomotive is equipped with one two-feed hydrostatic lubricator for the stoker, one of the feeds being blank. Ten of the engines are equipped with Nathan mechanical lubricators, while the other ten are equipped with Detroit mechanical lubricators. The air pumps are lubricated by a six-feed, force-feed mechanical lubricator furnished by the Westinghouse Air Brake Company. Soft grease lubrication is used for motion work, the bell, spring rigging, brake rigging and engine- and trailer-truck surfaces.

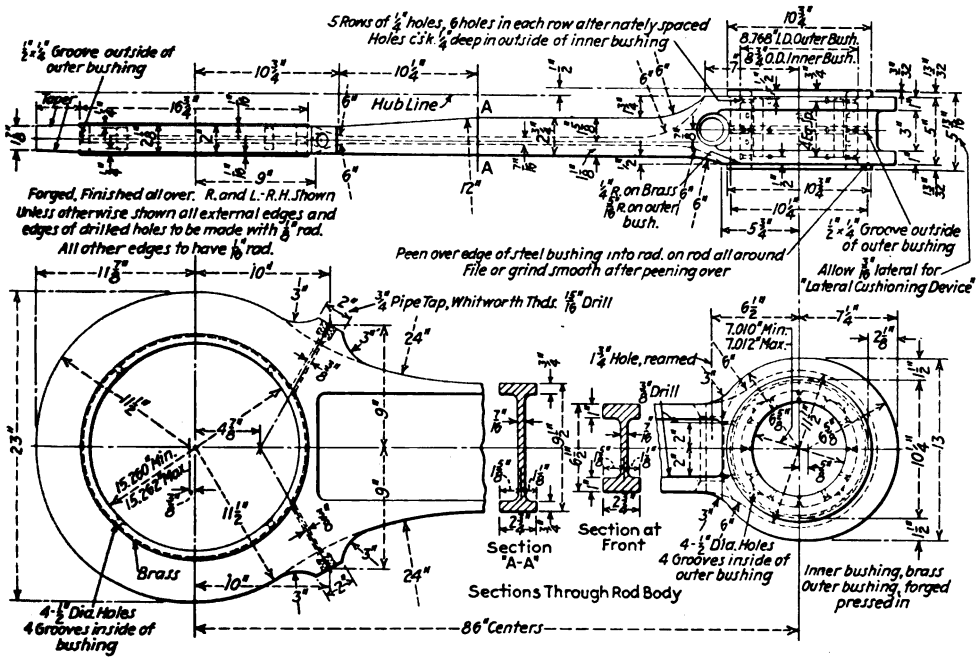
On those engines equipped with Nathan mechanical lubricators, a DV-4 20-pt. model is used on the right side, while a DV-5 26-pt. model is used on the left side. From the lubricator on the right side one feed runs to the top of the cylinder barrel, one feed to the bottom of the cylinder barrel, two feeds to the steam chest and one feed to the throttle pilot valve, all these feeds being fitted with atomizers. From the lubricator on the left side eight feeds run to the driving boxes, with a four-way divider in each line, to feed oil to the two pedestal faces and to both sides of a Franklin snubber wedge. Two feeds run to the trailer truck, each line having a four-way divider, thus furnishing lubrication for the eight pedestal faces. One feed with a four-way divider furnishes lubrication for the guides.

On those engines equipped with Detroit mechanical lubricators a Model A 24-pt. unit is used on the right side and a Model B 32-pt. unit is used on the left side. The lubricator on the right side has four feeds to the cylinders through four-way dividers and high-pressure checks, two feeds to the steam chest, and one feed to the throttle pilot valve. The lubricator on the left side furnishes lubrication for the same parts as explained for the Nathan lubricator.

The Boiler

The boiler is conical in form with an inside diameter at the first course of 86 3/16 in. and an inside diameter at the third course of 100 in. It has a 30-in. steam space over the crown sheet. The barrel courses, welt strips and roof sheets are of silico-manganese steel which has a tensile strength of 70,000 lb. per sq. in. The inside dimensions of the firebox are 150 1/16 in. by 96 3/16 in., and the length of the combustion chamber is 72 in. There are five 4-in. arch tubes. The fuel is burned on Firebar grates fed by a Standard type BK stoker.

The side sheets and crown sheets are separate and are joined by welding. The inside throat sheet and combustion chamber are welded into the crown and side sheets. Flannery flexible staybolts are applied as follows: 166 in the throat sheet; 278 in the back head; 432 in the side sheets, and 656 in the crown sheet—a total of 1,532. These staybolts are of Lewis iron on six engines, Ewald iron on four engines, Burden iron on five engines, and Ulster iron on five engines. The rigid staybolts on each of five engines are of Lewis, Ewald, Ulster and Burden iron, respectively. All water-space rigid and flexible staybolts are hollow drilled. Seal welding is employed on both the inside and outside sheets at the mud-ring corners and at the junction of the longitudinal and circumferential barrel-course joints, according to the builder's practice.

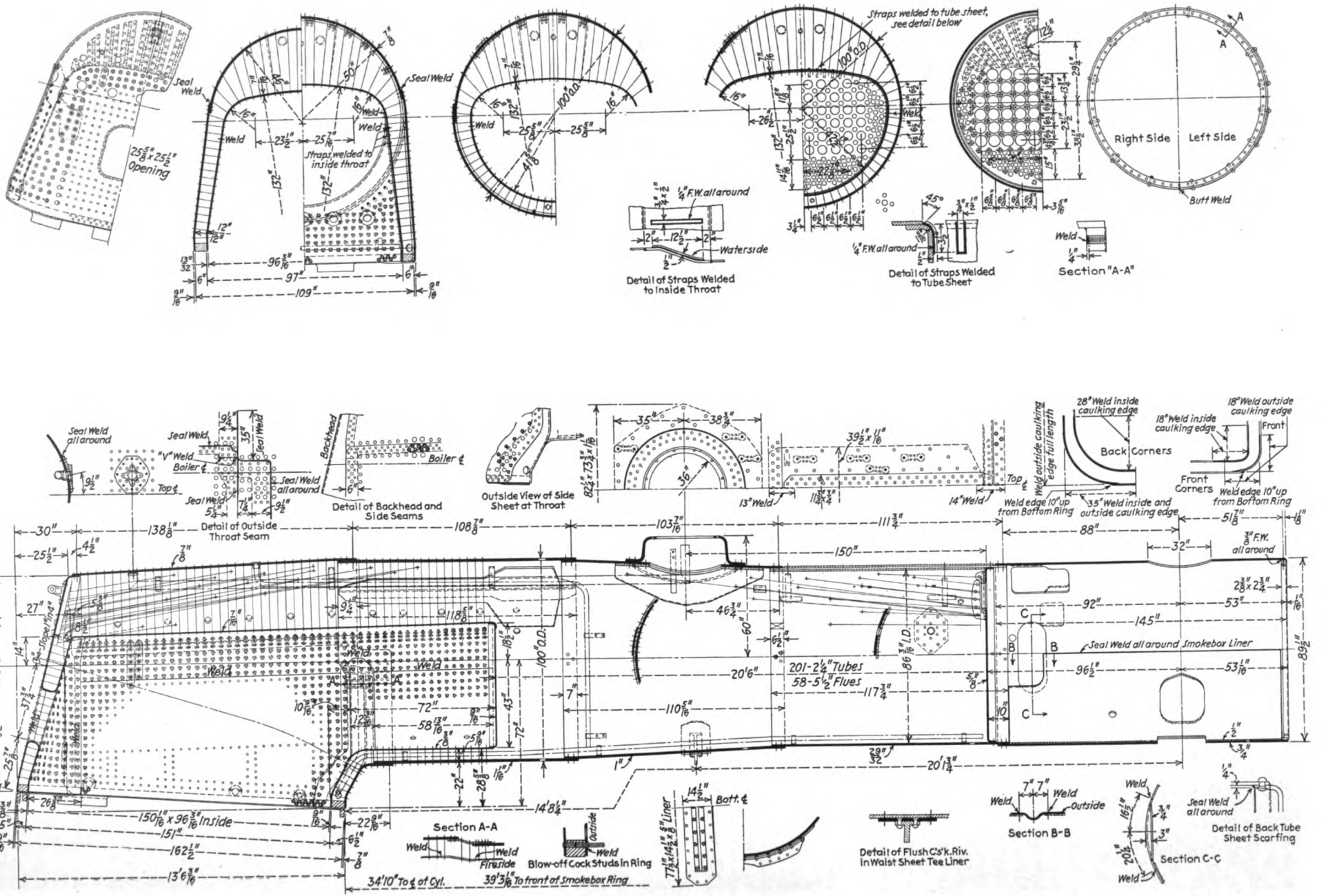


Details of the front section of the side rods

The locomotives have 201 tubes of 2¼ in. diameter and 58 hot-rolled seamless-steel 5½-in superheater flues. The length of flues and tubes is 20 ft. 6 in. The tubes have a heating surface of 2,415 sq. ft.; the flues, 1,703 sq. ft.; the firebox, 422 sq. ft.; the arch tubes, 57 sq. ft. The superheating surface is 1,473 sq. ft.

Each of the locomotives is equipped with one Nathan non-lifting injector, one Sellers exhaust steam injector, and Nathan 3-in. and Sellers 3-in. boiler checks, each of 10,000 gal. per hr. capacity, on the right and left side of the locomotive, respectively. The pipes to the check valves are led into recesses in the side of the smokebox sheets to assure unobstructed vision from the cab. The injector steam pipes on the right side are set down to the running board and under the jacket to improve the engineman's vision.

The locomotives are each equipped with an Elesco tangential steam dryer in the dome; a Franklin firedoor;



Cross-sections and elevation of the boiler of the Union Pacific 4-8-4 passenger locomotive

American arch brick; two Wiltbonco reflex type water glasses; Prime gage cocks; Hancock and Lukenheimer valves; Wilson blow-off cocks; two Nathan No. 2 drop plugs at the lowest point in the crown sheet; individual saturated-steam drypipe for the whistle, and American front-end throttle. The front end is the Master Mechanic type with the railroad company's standard exhaust pipes and 24-in. stack.

The boiler is supported between the No. 2 and 3 drivers and at the front and rear of the firebox by bearers with sliding shoes which float in oil. A cast bracket is bolted to a Tee, which is rigidly secured to a liner over the bearer, which is in turn attached to the boiler. A sheet-metal casing is attached to the bed, completely enclosing the shoe, and is oil-tight to retain the oil bath. The cover attached to the firebox support slides over the casing openings in the top of the cover.

The cab, as noted on the erecting drawing, is entirely supported from the locomotive boiler and not from the frames. The cab floor is supported by a separate casting which forms also the support for the stoker, grate shaker fulcrums and brake pedestal. The running boards are of $\frac{3}{16}$-in. plate, perforated with 1-in. holes.

The Tenders

The tenders have cast-steel water-bottom underframes. with U-shaped tanks, each having a capacity of 20,000 gallons of water and 25 tons of coal. Five of the tenders are equipped with Buckeye six-wheel trucks, while the remaining 15 are equipped with Commonwealth six-wheel trucks, all fitted with SKF roller bearings. The engine-tender connections are Unit safety bars with Franklin type E radial buffer. At the rear end, the tenders are fitted with Miner A5XB draft gears, A. S. F. cast-steel coupler yokes, and National Malleable & Steel Casting Company swivel-butt couplers. The tanks have four manholes, with a wooden platform around each hole. Simplex unit-cylinder clasp brakes with double brake shoes are fitted on the trucks.

Partial List of Materials and Equipment on the Union Pacific 4-8-4 Type Locomotives

Locomotive bed casting	General Steel Castings Corp., Eddystone, Pa.
Staybolt iron, flexible stays	(6) Lewis Bolt & Nut Co., Minneapolis, Minn. (4) Ewald Iron Co., Louisville, Ky. (5) Burden Iron Co., Troy, N. Y. (5) Ulster Iron Works, Dover, N. J.
Staybolt iron, rigid stays	(5) Lewis Bolt & Nut Co., Minneapolis, Minn. (5) Ewald Iron Co., Louisville, Ky. (5) Burden Iron Co., Troy, N. Y. (5) Ulster Iron Works, Dover, N. J.
Flexible staybolts	Flannery Bolt Co., Bridgeville, Pa.
Fire brick	American Arch Co., Inc., New York
Fire door	Franklin Railway Supply Co., Inc., New York
Superheater, Type A	The Superheater Company, New York
Superheater flues	(5) Globe Steel Tubes Co., Milwaukee, Wis. (10) National Tube Co., Pittsburgh, Pa. (5) Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Stoker, Standard BK	Standard Stoker Co., Inc., New York
Grates, Firebar	Waugh Equipment Company, New York
Smokebox hinges, cast-steel, front..	The Okadee Company, Chicago
Front-end throttle	American Throttle Co., Inc., New York
Boiler drop plug	Nathan Mfg. Co., New York
Boiler tubes	(5) Globe Steel Tubes Co., Milwaukee, Wis. (5) National Tube Co., Pittsburgh, Pa. (5-Electrunite) Steel & Tubes, Inc., Cleveland, Ohio (5) Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Washout plugs	(10) The Prime Manufacturing Co., Milwaukee, Wis. (10) Huron Mfg. Co., Detroit, Mich.
Lagging, pipe	Union Asbestos & Rubber Co., Chicago
Injector, non-lifting (one per locomotive)	Nathan Mfg. Co., New York
Exhaust steam injector (one per locomotive)	Wm. Sellers & Co., Inc., Philadelphia, Pa.
Strainers for exhaust steam injectors	Wm. Sellers & Co., Inc., Philadelphia, Pa.
Blow-off cocks with sludge remover.	Wilson Engineering Corporation, Chicago
Feed pipe strainer	T-Z Railway Equipment Co., Chicago
Boiler check: Right side Left side	Nathan Mfg. Co., New York Wm. Sellers & Co., Inc., Philadelphia, Pa.
Water gages, reflex type, Wiltbonco (two per locomotive)	Nathan Mfg. Co., New York
Steam gage; Back pressure cut-off control gage; Safety valves..	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Elesco tangential steam dryer	Superheater Company, New York
Lightweight valve, 12 in. diameter, with H-S Duplex sectional valve packing rings	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Blower valve, stoker valve	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Valves	The Lunkenheimer Company, Cincinnati, Ohio
Gage cocks	The Prime Manufacturing Co., Milwaukee, Wis.
Steam-heat equipment: Steam-heat valve and steam heat gage	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Pressure reducing valve	Vapor Car Heating Co., Inc., Chicago
Flexible joints between engine and tender	Franklin Railway Supply Co., Inc., New York
Flexible joints at rear end of tender	Vapor Car Heating Co., Inc., Chicago
Steam valves at turret	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Wovenstone on flexible connections between engine and tender and on exhaust steam pipe to Sellers injector	Union Asbestos & Rubber Co., Chicago
Fiberglass insulation in cab (except roof) and cab ventilators, side	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Clear vision window and cab storm windows	The Prime Manufacturing Co., Milwaukee, Wis.
Engineman's seat	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Bell Ringer	Railway Service and Supply Corp., Indianapolis, Ind.
Whistle	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Sanders	Viloco Railway Equipment Co., Chicago
Reverse gear: Ragonnet Type E	(15) Franklin Railway Supply Co., Inc., New York
Alco Type G	(5) American Locomotive Co., New York
Joints in steam line to reverse gear.	Barco Mfg. Co., Chicago
Cylinder cocks	The Prime Manufacturing Co., Milwaukee, Wis.
Cylinder cock mufflers	Wilson Engineering Corporation, Chicago
Cylinder and piston-valve bushings..	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Comb. bull and bronze "T" type packing rings	Locomotive Finished Material Co., Atchison, Kan.
Piston rod and valve-stem packing..	Paxton-Mitchell Co., Omaha, Neb.
Commonwealth four-wheel Delta type truck	General Steel Castings Corp., Eddystone, Pa.
Cast-steel engine truck, four wheel, U. P. type	American Locomotive Co., New York
Driving wheels, Boxpok	Standard Steel Works Co., Burnham, Pa.
Enginetruck wheels, rolled	Standard Steel Works Co., Burnham, Pa.
Front trailer-truck wheels rolled ..	American Locomotive Co., Railway Steel Spring Div., New York
Springs, Elliptic, Chrome-vanadium and others	National Malleable and Steel Castings Co., Cleveland, Ohio
Spring washers	SKF Industries, Philadelphia, Pa.
Engine and trailer-truck roller bearings	The Timken Roller Bearing Company, Canton, Ohio
Driving-box roller bearings	Franklin Railway Supply Co., Inc., New York
Unit type safety drawbar and radial buffer, type E	American Locomotive Co., New York
Lateral cushioning device	(10) Nathan Mfg. Co., New York
Lubricators, mechanical	(10) Detroit Lubricator Co., Detroit, Mich.
Shoes and wedges, automatic compensator and snubber	Franklin Railway Supply Co., Inc., New York

Air pump packing	Union Asbestos & Rubber Co., Chicago
Air brake gage	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Brake indicating gage	U. S. Metallic Packing Co., Philadelphia, Pa.
Tender:	
Frame, cast steel water bottom.	General Steel Castings Corp., Eddystone, Pa.
Trucks, cast steel, six-axle	(5) Buckeye Steel Castings Co., Columbus, Ohio (15) General Steel Castings Corp., Eddystone, Pa.
Wheels	(10) Standard Steel Works Co., Burnham, Pa. (10) American Steel Foundries, Chicago
Roller bearings	SKF Industries, Philadelphia, Pa.
Unit cylinder clasp brakes	American Steel Foundries, Chicago
Draft gear, A5XB spring type.	W. H. Miner, Inc., Chicago
Coupler yoke, cast steel	American Steel Foundries, Chicago
Coupler, swivel but	National Malleable and Steel Castings Co., Cleveland, Ohio.
Uncoupling rigging, rotary, bottom operated, Imperial	Union Metal Products Co., Chicago
Train number indicator	The Adams & Westlake Co., Elkhart, Ind.
Headlight and generator	(15) The Pyle-National Co., Chicago (5-Sunbeam) General Electric Company, Schenectady, N. Y.
Automatic train control (cab signals)	Union Switch & Signal Co., Swissvale, Pa.

A Study, Based on Laboratory Results, of

The Locomotive Front End

Part II

Gas Flow

By H. S. Vincent*

An investigation of the laws which govern the flow of steam and gas in a locomotive front end—The author discusses the feasibility of reducing back pressure in locomotive cylinders

As stated in Part I of this article, published in the January issue, the main purpose of the locomotive front-end mechanism is to move the maximum quantity of gases of combustion across the locomotive heating surfaces with the minimum expenditure of energy.

In estimating the weight of gases to be moved in unit time, it is necessary to have the following data: (*a*) Weight of fuel fired per unit of time, usually, lb. per sq. ft. of grate surface per hr.; (*b*) ratio of fuel burned to fuel fired; (*c*) weight of gas generated per lb. of fuel fired; and (*d*) boiler efficiency. The method of calculating items (*b*), (*c*) and (*d*) is fully discussed by the writer in an earlier paper,[5] so it need not be repeated.

In relating the steam flow M_o through the nozzle to the unit weight of fuel fired G

$$M_o = \frac{K\,(mG - nG^2)\,R_o\,C_f}{3600\,H_2} \qquad (15)$$

[5] "Heat Transmission in Locomotive Boilers," by H. S. Vincent, *Railway Mechanical Engineer*, vol. 109, May, June and August, 1935, pages 180, 228 and 335, respectively.

The coefficient C_f was determined by plotting the curve which most nearly conforms to the test data. For locomotive *A*, this curve is illustrated by Fig. 16. Curves for the other seven locomotives were constructed in a similar manner. The coefficient C_f is the proportion of the heat in the fuel imparted to the steam which appears at the nozzle exit. For locomotive *A*, $C_f = 0.87$. For all the tests discussed, it ranges from 0.83 to 0.89.

The quantity H_2 in equation (15) is the average value of the enthalpy of the steam at the nozzle exit. It apparently bears a straight-line relation to the unit weight

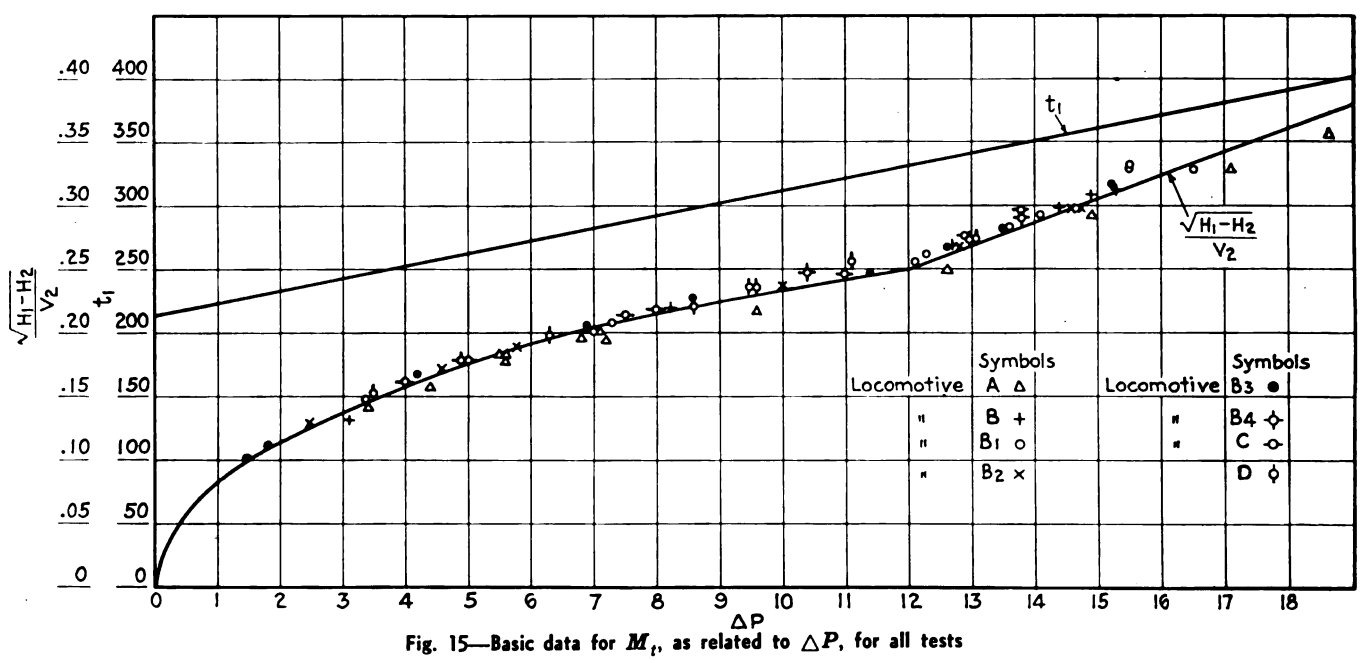


Fig. 15—Basic data for M_t, as related to ΔP, for all tests

of coal fired G. The value of H_2, as determined for locomotive A, is shown in Fig. 17 where

$$H_2 = 1176 + 0.0857G \quad \ldots\ldots (16)$$

The weight of gas flowing across the heating surfaces per pound of steam exhausted from the nozzle, is

$$C_s = \frac{C_g\ C_b\ G\ R_o}{3600\ M_o} = \frac{W_f\ G\ R_o}{3600\ M_o} \quad \ldots\ldots (17)$$

The weight of gas per second flowing over the heating surfaces is

$$W_g = M_o\ C_s \quad \ldots\ldots (18)$$

The value of C_s, as related to M_o, for the eight locomotives being discussed is shown in Figs. 5A to 12A,

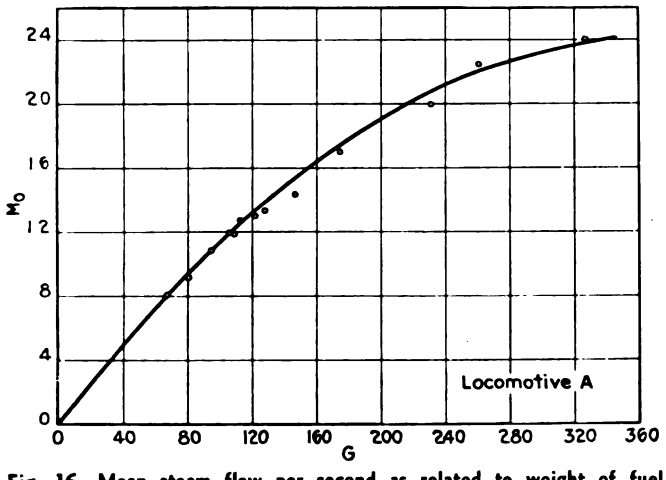


Fig. 16—Mean steam flow per second as related to weight of fuel fired per square foot of grate surface per hour for locomotive *A*

inclusive. The relation between W_g and M_o is shown in Figs. 5B to 12B, inclusive. It will be observed that the smooth curve for W_g very closely approximates the actual gas flow as determined from the tests and indicated by the small circles.

The method of assembling the data for the curves C_s and W_g is illustrated by Table VI, applying to locomotive A.

The relation between W_g and ΔP is shown by Figs. 5C to 12C, for all the tests being discussed.

The relation between M_o and $\sqrt{\Delta P}$, between M_o and W_g, and between W_g and ΔP, for the eight locomotives, are shown in Figs. 18, 18B and 18C, respectively. It will be seen from Fig. 18, that for all values of $\sqrt{\Delta P}$, the M_o curves fall in the same order as the nozzle area. In Fig. 18B, the gas flow per second from zero to $M_o = 12$ is almost identical for locomotives A and D, although the nozzle areas and smokebox arrangements of these locomotives are very dissimilar. By following the vertical lines through to their intersection with the M_o curves in Fig. 18 it will be seen that although the same weight of gas is being moved, the value of ΔP, required to move it, is very different.

The advantage derived from improvement in front-end design is well illustrated in Fig. 18C by comparing the curves for locomotives B, B_1 and B_2. Reference to Fig. 1 will show that locomotive B is equipped with the Master Mechanics front-end arrangement including a Goodfellow nozzle having an area of 0.25 sq. ft. Locomotive B_1 has the same smokebox arrangement but is equipped with a six-point star nozzle having an area of 0.28 sq. ft. At $\Delta P = 12$, the gas moved per second by locomotive B_1 is over 18 per cent greater than for locomotive B. A further improvement is effected by applying the smokebox arrangement shown in Fig. 1 for locomotive B_2, and using a six-point star nozzle having an area of 0.3335 sq. ft. At the same pressure, the gas moved by locomotive B_2 is 27.6 per cent greater than for locomotive B. It must be remembered that overwise than mentioned above, locomotives B, B_1 and B_2 are identical in design.

In the model tests previously referred to,[1]* when using a circular nozzle 1½ in. in diameter, the air flow per pound of steam as tabulated in Appendix G, Bulletin No. 256,[1] varied directly as the weight of steam emitted through the nozzle. This is shown in Fig. 19B. It cannot be expected that in the actual locomotive a similar relation will exist. In the model test, the air moving into the smokebox was limited only by a predetermined and constant resistance. In a locomotive, the gas supply is subject to a number of limiting factors, the value of which is constantly changing.

Table VI—Calculated Data for Plotting Fig. 16

1 G	2[a] C_s	3 H_2	4 $mG-nG^2$	5[b] W_f	6[c] M_o	7 C_f	8[d] W_g
20	2.210	1177.5	12.85	14.52	2.55	0.87	5.63
40	2.185	1179.3	25.00	13.92	4.95	0.87	10.81
60	2.158	1180.1	36.45	13.33	7.21	0.87	15.55
80	2.130	1182.5	47.20	12.77	9.33	0.87	19.87
100	2.100	1184.2	57.24	12.20	11.31	0.87	23.75
120	2.070	1186.0	66.60	11.67	13.14	0.87	27.20
140	2.045	1187.9	75.25	11.13	14.80	0.87	30.28
160	2.016	1189.6	83.20	10.60	16.35	0.87	32.95
180	1.990	1191.2	90.45	10.09	17.74	0.87	35.30
200	1.960	1193.0	97.00	9.59	19.00	0.87	37.25
220	1.936	1194.7	102.80	9.10	20.10	0.87	38.90
240	1.912	1196.2	108.00	8.62	21.10	0.87	40.40
260	1.882	1198.1	112.30	8.16	21.90	0.87	41.20
280	1.849	1200.0	116.20	7.70	22.61	0.87	41.82
300	1.826	1201.9	119.20	7.26	23.19	0.87	42.30
320	1.797	1203.8	121.60	6.83	23.60	0.87	42.41
340	1.773	1205.6	123.30	6.41	23.88	0.87	42.30

Notes: [a] See equation (17). [b] See equation (25). [c] See equation (8). [d] See equation (18). For definition of the terms in the column headings and their units, see Table III.

The air flow as determined on the model, for a series of circular nozzles, at various increments of P_s and with an identical smokebox arrangement, is taken from the Table 17, Appendix D, Bulletin No. 256.[1] These

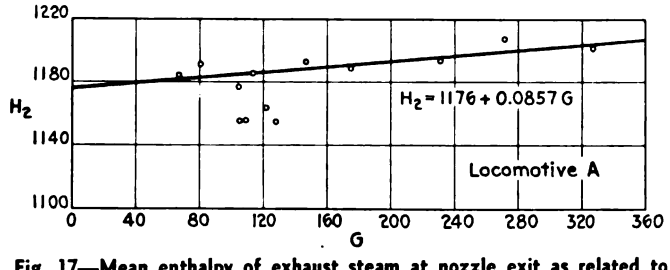


Fig. 17—Mean enthalpy of exhaust steam at nozzle exit as related to weight of fuel fired per square foot of grate surface per hour for locomotive *A*

data have been assembled in Fig. 20 in which the hourly air flow is shown in relation to the nozzle area. It will be seen from this exhibit that in these tests the air flow for all values of P_s varies as the cube root of the nozzle area. Having this law established, it is possible to assess the relative effectiveness of different constructions by direct comparison with the standard.

Fig. 6 of Bulletin No. 274 [1] gives the results of a test with a four hole "pepper-box" type of nozzle, having the same area as the 1½-in. circular nozzle and using the Master Mechanics standard front-end construction. At $P_s = 8$, the weight of air moved per hour with the pepper-box nozzle was 5,250 lb. or 19.8 per cent greater than with the equivalent circular nozzle operating under similar conditions. When the same pepper-

* Footnotes 1, 2, 3 and 4 were published with Part I of this article in the January issue.

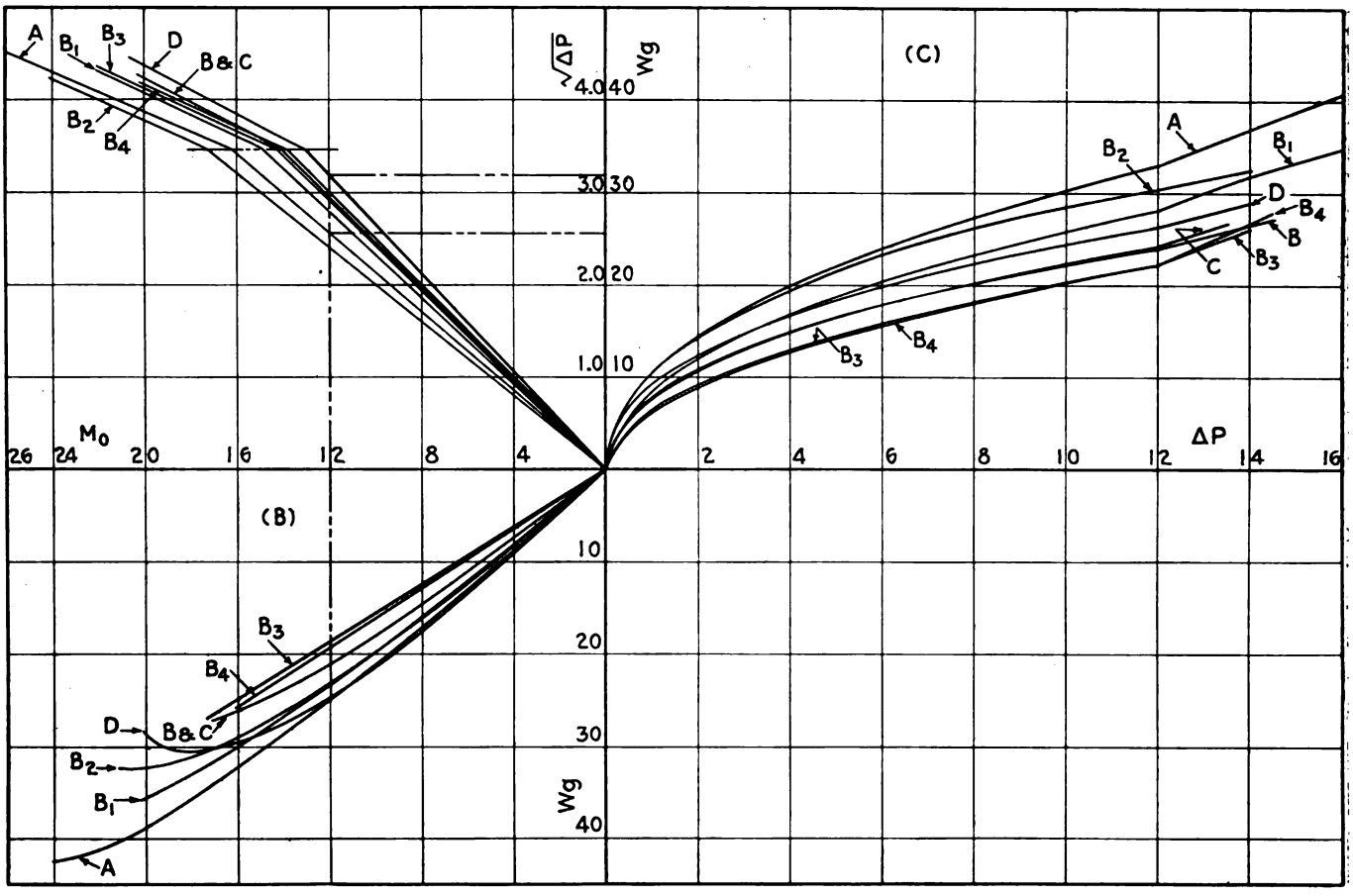


Fig. 18—Steam flow per second as related to ΔP, gas flow per second as related to steam flow, and gas flow as related to ΔP for the eight locomotives

box nozzle was applied in conjunction with a gyratory spark arrestor, arrangement *GB*, the increase over the circular nozzle and standard front-end arrangement was 27.6 per cent, of which 19.8 per cent was due to the design of the nozzle and 7.8 per cent to the spark arrester. These percentages are easily determined from Fig. 20.

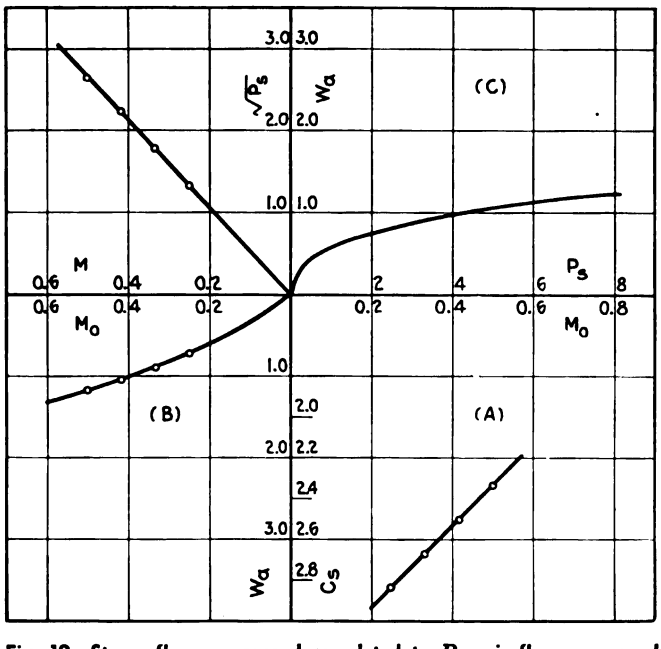


Fig. 19—Steam flow per second as related to P_S, air flow per pound of steam, air flow per second, and gas flow as related to P_S for Young's tests of model Master Mechanics front end with a 1½-in. circular nozzle

In the test of a six-hole pepper-box nozzle having an area of 1.841 sq. in., employing the *GB* spark arrester, the air moved per hour at $P_s = 8$ was 5,432 lb. or 22 per cent more than an equivalent round nozzle of the same area. It was therefore less efficient than the nozzle with four holes.

A star-shaped nozzle having an area of 1.959 sq. in. was tested using the *GB* arrangement. The air moved per hour at $P_s = 5$ was 4,205 lb., or 6.7 per cent more than for an equivalent round nozzle with Master Mechanics arrangement.

It is evident from Fig. 20 that increasing the area of a nozzle has the effect of moving a greater weight of air for any given value of ΔP or P_s. This, however, involves an increase in the weight of steam flowing through the nozzle. In Fig. 21 is shown the weight of air moved per hour, as related to P_s, for the various sizes of circular nozzles tested by Young.[1] In this figure is indicated, by the dashed curved lines, the effect of flowing constant weights of 1,300 and 1,550 lb. of steam per hr. through the nozzle. As the nozzle is increased in area, the weight of air moved decreases. This exhibit explains the reason for the common practice of reducing the nozzle area to make a locomotive steam better. It is, however, always done at the expense of higher back pressure.

It has been proved by Fig. 20 that the equation

$$W_a \propto \sqrt[3]{A_2} \qquad (19)$$

accurately represents the model tests. There is apparently no reason why the equation cannot be applied to the actual locomotive by substituting W_g for W_a. This has been done as shown in Fig. 22, which applies to the eight locomotives being discussed. Inasmuch as these locomotives embody a variety of nozzle shapes and

smokebox arrangements, it is necessary to select one set of conditions as a basis for calculating the curves of ΔP. In Fig. 22, locomotive B has been used as a base, since it represents the present standard front-end construction, viz, Master Mechanic arrangement of drafting apparatus, Goodfellow nozzle having an area of 0.25 sq. ft., and with the superheater damper eliminated as shown in Fig. 1.

Locomotive B will first be compared with locomotive B_1. Both locomotives have exactly the same smokebox

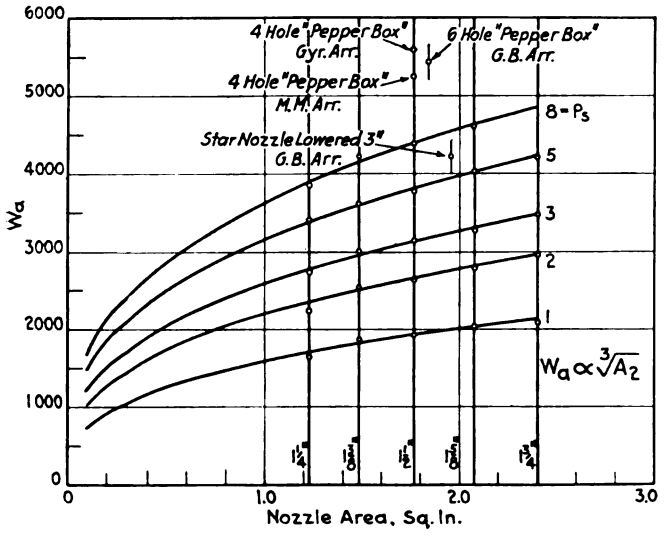


Fig. 20—Relation between the weight of air moved per hour and nozzle area (data taken from Table 16 of Appendix C and Table 17 of Appendix D, Bulletin No. 256 Engineering Experiment Station, University of Illinois.)

arrangement but B_1 is equipped with a six-point star nozzle having an area of 0.28 sq. ft. At $\Delta P = 12$, the gas moved by locomotive B_1 is 18 per cent greater than for locomotive B. Of this increase, 4.5 per cent is due to the increased area of the nozzle and 13.5 per cent to its improved contour. At $\Delta P = 10$, locomotive B_1 moved 16.3 per cent more gas than locomotive B, of which 4.2 per cent is due to increased area and 12.1 per cent to nozzle contour. At $\Delta P = 8$, the percentages of increase are 4.8 and 10.2, respectively. These are readily determined by inspection of Fig. 22.

A similar comparison will next be made between locomotives B_1 and B_2. The latter has an improved smokebox arrangement with a six-point star-nozzle having an area of 0.3335 sq. ft., as illustrated in Fig. 1. At $\Delta P = 12$, the weight of gas moved by locomotive B_2 is 8.2 per cent greater than for B_1; of this, 2.2 per cent is due to increased nozzle area and 6.0 per cent to improved front-end construction. At $\Delta P = 10$, the gas moved by locomotive B_2 is 10.5 per cent greater than for B_1; of this, 4.3 per cent is chargeable to increased nozzle area and 6.2 per cent to improved front-end construction. At $\Delta P = 8$, the percentages of increase are 7.3 and 6.4, respectively.

It will be seen from column 19 of Table II, for locomotive B_2, that the weight of gas passing over the heating surfaces decreases with increasing fuel consumption. This is reflected in the low value of ΔP found in Fig. 22, for this locomotive.

Comparison has now been made between three locomotives, identical in general design and differing only in the drafting apparatus. The next comparison is between the very dissimilar locomotives B_1 and A, the smokebox arrangements for which are shown in Fig. 1. At $\Delta P = 12$, the weight of gas moved per hour by locomotive A was 17 per cent greater than for locomotive B_1. The proportion of the increase due to the larger nozzle is 4.7 per cent. The improved front end and lower resistance to gas flow accounts for the remaining 12.3 per cent. Probably about half of this is due to the front-end arrangement.

At $\Delta P = 10$ and also at $\Delta P = 8$, the gas moved by locomotive A was 18 per cent greater than for B_1; of this, the nozzle accounted for 4.8 per cent and 4.5 per cent, respectively.

Locomotives B, B_3 and B_4, as previously stated, are practically identical in design, having the same smokebox arrangement except that locomotives B_3 and B_4 have a superheater damper and larger nozzles as indicated in Table IV. The position of the small circles representing ΔP, for locomotives B_3 and B_4, in Fig. 22, fall below the curves based on locomotive B. This is caused by the resistance to gas flow offered by the superheater damper. At $\Delta P = 12$, the reduction in the gas flow from this cause is from 8 to 9 per cent.

The comparisons given here illustrate what can be accomplished in the reduction of ΔP by improvement in nozzle and front-end design.

Smoke Stack

Young and other experimenters have shown that the correct diameter of the smoke stack is essential to the proper functioning of any front-end arrangement. In the report of the A.A.R. Committee,[2] referred to previously, it is recommended that the minimum area of the stack be 25 per cent of the net tube and flue area and that the area of the nozzle be determined from the stack dimensions. It would seem that this is approaching the

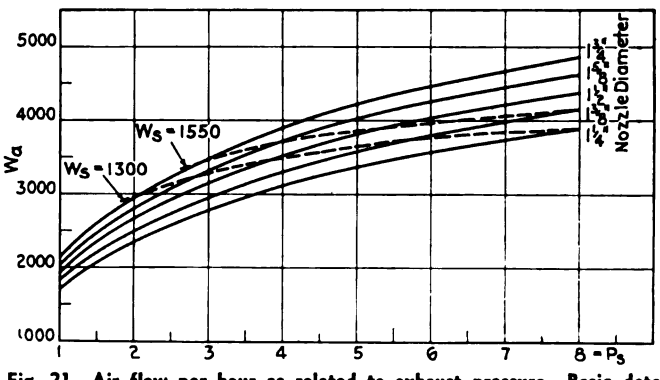


Fig. 21—Air flow per hour as related to exhaust pressure—Basic data was obtained from the source mentioned in Fig. 20

problem from the wrong direction, that is, the area of the nozzle should be first determined.

To fix the proper stack diameter for any locomotive, it is essential to know approximately the flare of the steam jet, or the angle it makes with the vertical center of the nozzle. The A.A.R. report[2] gives this angle as 6 deg. for bridged nozzles when ΔP ranges from 8 to 10. The tests made by Young [1] with round nozzles indicate that the flare of the jet varies with P_s. For the 1½-in. nozzle and typical locomotive stack, the flare was found to be 7 deg. 8 min. when $P_s = 1$ on the model, and was 6 deg. 35 min. when $P_s = 5$ on the model.

Assuming that the model test is more nearly correct, then

$$a = 6.58 + 0.029 \Delta P \quad \ldots\ldots (20)$$

It is not clear why the application of a bridge should make a difference in the flare of the jet, since the flare is conditioned by the lip of the nozzle, which in practically all cases forms an angle of 90 deg. with the vertical.

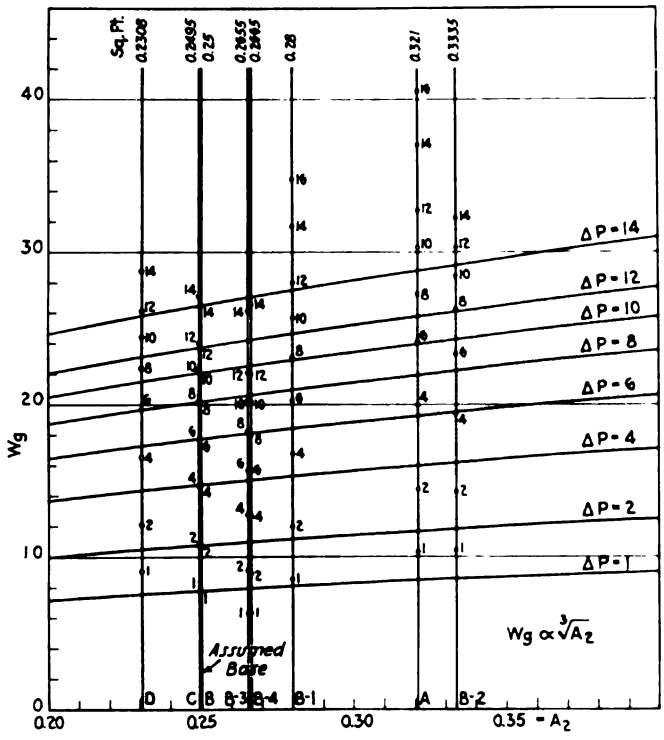


Fig. 22—Relation between gas flow per second Wg and nozzle area A_2 for the eight locomotive tests

(Circles represent the actual variation between ΔP and Wg, as developed in the tests.)

The point where the jet impinges on the periphery of the stack is shown in Fig. 1 for each of the arrangements, assuming a jet flare of 6 deg. It will be noted that the point of impingement, with reference to the top of the stack, varies greatly. The recommendation of the A.A.R. Committee,[2] that the sealing point of the jet be 12 in. below the top of the stack, seems reasonable where circular nozzles are used. It is evident that the area between the jet and the stack, below the sealing point, should be as great as practicable in order to give the jet its maximum entraining surface.

If L = the distance from the nozzle to the point of seal in a straight stack, D = the diameter of the stack and d = the diameter of the nozzle, then

$$D = d + (2L \tan a) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (21)$$

For tapered stacks it is more convenient to plot the required diameter D_1 at the point of impingement of the jet. For other than circular nozzles, equation (21) can be used by making the maximum dimension of the nozzle = d.

Reference to Fig. 23 will show that some allowance must be made in the calculation of the dimension L when other than a circular nozzle is used. If a section

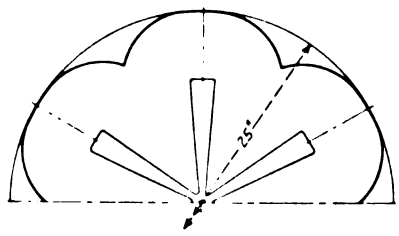


Fig. 23—Development at the point of impingement in a 25-in. stack of the jet from a six-point star nozzle

is taken through the jet at the point where it should impinge on the stack, in accordance with equation (21), it will be seen that for the star-type nozzle there are six points in the periphery of the jet which theoretically do not touch the stack at the dimension L, but which must be carried to a higher plane before contacting the stack. Therefore, for other than circular nozzles it is desirable to fix the normal point of impingement at a distance of from 24 in. to 30 in. from the top of the stack.

Part III of this article will appear in a subsequent issue.

Annual Report of Bureau of

Locomotive Inspection

Locomotives inspected, the number ordered from service and number of defects found increase, but the per cent found defective remained the same as for the preceding three years —Accidents and deaths increase over those reported in 1936

THE annual report of the Bureau of locomotive inspection submitted by John M. Hall, chief inspector, which covers the fiscal year ended June 30, 1937, shows an increase over 1936 in the number of locomotives inspected, the number found defective, the number ordered out of service, and the number of defects found; however, the percentage of locomotives inspected which were found defective remained at 12 per cent as for the preceding three years. There was an increase of 9.6 per cent over 1936 in the number of locomotives ordered from service because of defects which rendered the locomotive immediately unsafe.

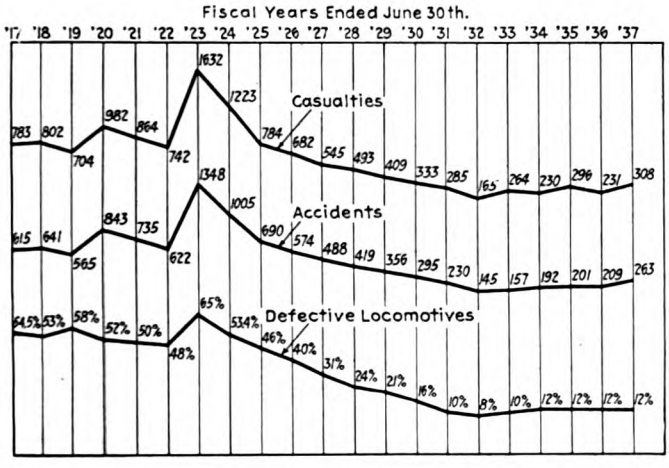
In addition to the accidents shown in the tables and otherwise referred to in this report, there was reported to the bureau a total of 87 accidents in which four employees were killed and 83 employees injured in falls while in the performance of their duties on locomotives. None of these falls could be attributed to any features encountered in connection with the condition of locomotives, it being apparent in each instance that the falls were caused by inattention or sudden illness on the part of those killed and injured. These accidents do not come within the scope of the locomotive inspection law but are mentioned here in order to emphasize the necessity of alertness on the part of all persons employed on or about locomotives.

Steam Locomotives

During the fiscal year ended June 30, 1937, the number of steam locomotives inspected totaled 100,033 of

which 12,402 or 12 per cent were found defective and 934 were ordered out of service, the latter figure representing an increase of 9.6 per cent from the preceding year. In 1936, there were 97,329 locomotives inspected, of which 11,526 were found defective and 852 were ordered out of service. In the year ending June 30, 1935, a total of 94,151 locomotives were inspected of which 11,071 were found defective and 921 were ordered out of service. The total number of defects shown in the last three reports were 44,941 in 1935, 47,553 in 1936 and 49,746 in 1937.

The total number of accidents caused by failure of



Relation of defective steam locomotives to accidents and casualties resulting from locomotive failures

some part of the steam locomotive, including boiler or tender was 201 in 1935, 209 in 1936 and 263 in 1937. The number of persons killed from such accidents were 29 in 1935, 16 in 1936 and 25 in 1937; the deaths in 1937 represent an increase of 52.2 per cent over the number of persons killed in 1936.

There was an increase of 54 in the number of accidents occurring in connection with steam locomotives,

Condition of Inspected Steam Locomotives and Their Relation to Accidents and Casualties*

Fiscal year ended June 30	Per cent of locomotives inspected found defective	Number locomotives ordered out of service	Number of accidents	Number of persons killed	Number of persons injured
1912	65.7	3,337	856	91	1,005
1915	44.4	2,027	425	13	467
1925	46.0	3,637	690	20	764
1926	40.0	3,281	574	22	660
1927	31.0	2,539	488	28	517
1928	24.0	1,725	419	30	463
1929	21.0	1,490	356	19	390
1930	16.0	1,200	295	13	320
1931	10.0	688	230	16	269
1932	8.0	527	145	9	156
1933	10.0	544	157	8	256
1934	12.0	754	192	7	223
1935	12.0	921	201	29	267
1936	12.0	852	209	16	215
1937	12.0	934	263	25	283

* The original act applied only to the locomotive boiler, but was amended in 1917 to include the entire locomotive and tender.

an increase of 9 in the number of persons killed, and an increase of 68 in the number of persons injured compared with the previous year. The chart shows the relation between the percentage of defective steam locomotives and the number of accidents and casualties resulting from failures thereof, and illustrates the effect of operating locomotives in defective condition.

There was an increase of one in the number of accidents, an increase of 9 in the number of persons killed, and an increase of 3 in the number of persons injured as a result of boiler explosions or crown-sheet accidents as compared with the previous year. The foregoing includes four deaths and two injuries that occurred as a result of a derailment followed by an explosion when the locomotive fell from a trestle and alighted on a highway 96 ft. below the level of the rails. The boiler was torn apart at the back-end connection seam and the cylindrical part of the boiler was hurled upward and forward; it struck the track 400 ft. ahead of the point of explosion and rebounded and came to rest 350 ft. further on, or a distance of 750 ft. from the point where the explosion occurred. The back end of the boiler was blown backward 50 ft. and parts of the locomotive and boiler were scattered over a radius of 1,000 ft.

In another explosion, caused by overheating the crown sheet due to low water, the boiler was blown 323 ft. forward and parts of the wreckage were scattered over a radius of 800 ft. This boiler was equipped with only one water glass, the top cock of which was found closed and the valve stem bent in such a manner as to indicate that it must have been closed prior to the explosion. Upon test on another locomotive one of the four safety valves did not open and when it was disassembled it was found that a piece of steel tubing had been substituted for the spring. A sworn report had been made at the last quarterly inspection 38 days before the accident that showed all four safety valves had been properly set at that time.

Boiler and appurtenance accidents other than explosions resulted in the death of 2 persons and the injury of 60 persons.

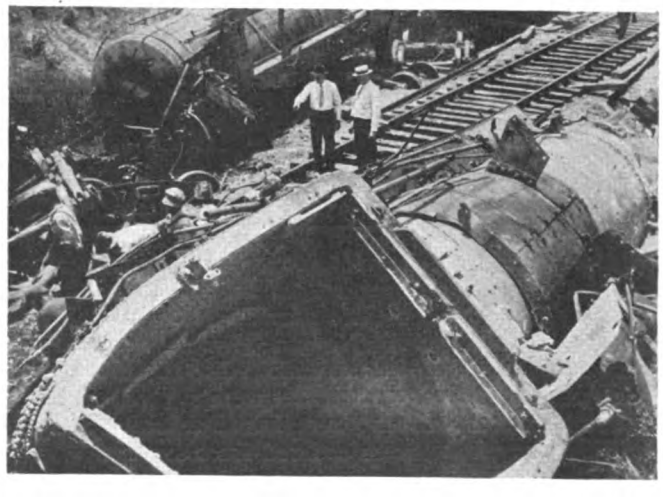
Extension of Time for Removal of Flues

Applications for extensions of time for removal of flues as provided for in rule 10 totaled 679. Of these, 50 were rejected, 41 were given extensions for a shorter time than requested, 35 were granted after defects found were repaired, 10 applications were canceled, and 543 extensions were granted for the full periods requested.

Locomotives Other Than Steam

There was an increase of three in the number of accidents occurring in connection with locomotives other than steam and an increase of five in the number of persons injured as compared with the previous year. No deaths occurred in either year.

During the fiscal year ended June 30, 1937, 3,615 locomotives other than steam were reported of which 328,



Low water caused this boiler explosion—The force of the explosion hurled the boiler forward 257 ft. from where it rebounded onto the track 57 ft. further on at which point it was rammed and pushed 493 ft. further by the running gear which had remained on the track

Number of Steam Locomotives Reported, Inspected, Found Defective, and Ordered From Service

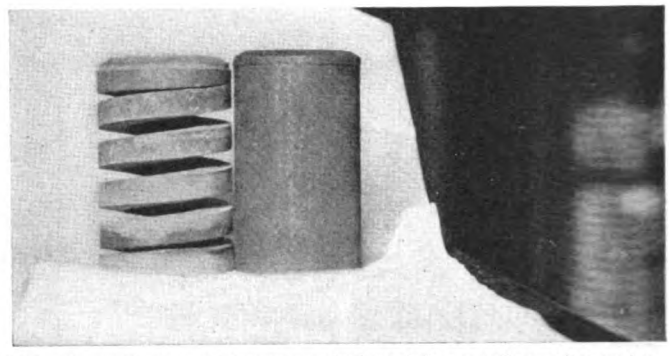
Parts defective, inoperative or missing, or in violation of rules	Year ended June 30— 1937	1936	1935	1934	1933	1932
1. Air compressors	766	740	733	660	474	417
2. Arch tubes	105	74	74	127	51	54
3. Ash pans and mechanism	80	79	94	87	40	69
4. Axles	10	13	10	6	21	13
5. Blow-off cocks	201	236	283	289	210	144
6. Boiler checks	382	356	413	407	293	214
7. Boiler shell	347	383	395	372	296	220
8. Brake equipment	2,322	2,480	2,449	2,326	1,696	1,645
9. Cabs, cab windows and curtains	1,807	1,638	1,273	1,342	1,183	851
10. Cab aprons and decks	466	450	368	343	309	262
11. Cab cards	145	166	142	129	121	162
12. Coupling and uncoupling devices	74	65	73	54	67	85
13. Crossheads, guides, pistons and piston rods	1,160	1,056	1,086	1,100	773	763
14. Crown bolts	76	63	75	77	67	50
15. Cylinders, saddles and steam chests	2,206	1,717	1,547	1,491	1,084	841
16. Cylinder cocks and rigging	729	605	627	654	374	376
17. Domes and dome caps	101	114	94	105	76	45
18. Draft gear	522	513	423	401	318	325
19. Draw gear	560	451	414	480	357	371
20. Driving boxes, shoes, wedges, pedestals and braces	1,637	1,712	1,573	1,472	1,080	821
21. Firebox sheets	371	295	343	356	246	235
22. Flues	225	178	173	203	150	120
23. Frames, tailpieces and braces, locomotive	1,053	997	1,006	951	669	611
24. Frames, tender	120	113	124	128	80	86
25. Gages and gage fittings, air	261	257	275	212	145	156
26. Gages and gage fittings, steam	324	350	320	289	258	214
27. Gage cocks	538	579	480	384	388	330
28. Grate shakers and fire doors	470	400	394	404	245	288
29. Handholds	510	502	464	377	363	382
30. Injectors, inoperative	38	40	39	33	20	31
31. Injectors and connections	2,020	2,085	2,035	1,909	1,357	1,168
32. Inspections and tests not made as required	9,638	9,005	8,344	8,173	6,358	3,801
33. Lateral motion	446	404	389	351	269	237
34. Lights, cab and classification	90	78	81	79	76	55
35. Lights, headlight	313	251	257	218	169	119
36. Lubricators and shields	254	255	191	215	157	119
37. Mud rings	272	237	241	247	232	166
38. Packing nuts	487	508	527	491	419	402
39. Packing, piston rod and valve stem	1,393	1,133	906	833	592	444
40. Pilot and pilot beams	133	178	152	174	123	145
41. Plugs and studs	238	236	167	242	151	176
42. Reversing gear	492	463	414	390	254	202
43. Rods, main and side, crank pins and collars	2,348	2,093	1,826	1,670	1,327	1,256
44. Safety valves	132	125	100	103	53	63
45. Sanders	653	678	779	697	376	289
46. Springs and spring rigging	3,172	3,008	2,765	2,854	2,122	1,851
47. Squirt hose	133	134	113	107	93	96
48. Stay bolts	276	279	140	285	219	181
49. Stay bolts, broken	542	520	512	455	368	552
50. Steam pipes	446	526	463	489	338	285
51. Steam valves	165	227	212	267	193	143
52. Steps	678	615	640	567	498	622
53. Tanks and tank valves	1,009	877	913	862	600	587
54. Telltale holes	79	127	102	93	90	108
55. Throttles and throttle rigging	909	760	733	639	448	434
56. Trucks, engine and trailing	785	861	811	898	664	648
57. Trucks, tender	1,018	1,108	1,120	918	747	766
58. Valve motion	798	824	799	784	640	520
59. Washout plugs	598	714	679	776	623	599
60. Train-control equipment	12	6	4	8	4	13
61. Water glasses, fittings and shields	1,049	1,118	951	907	716	676
62. Wheels	803	790	697	734	580	603
63. Miscellaneous—signal appliances, badge plates, brakes (hand)	759	608	563	572	423	325
Total number of defects	49,746	47,453	44,491	43,271	32,733	27,832
Locomotives reported	48,025	49,322	51,283	54,283	56,971	59,110
Locomotives inspected	100,033	97,329	94,151	89,716	87,658	96,924
Locomotives defective	12,402	11,526	11,071	10,713	8,388	7,724
Percentage of inspected found defective	12	12	12	12	10	8
Locomotives ordered out of service	934	852	921	754	544	527

or 9 per cent, were found defective, and 24 were ordered from service. This compares with 3,118 locomotives inspected during the previous year of which 252, or 8 per cent, were found defective and 11 were ordered from service. In 1933, 1934 and 1935, 1,368, 1,436 and 1,620 locomotives were inspected, respectively, of which 74, 69 and 146, respectively, were found defective and 3, 4, and 5, respectively, were ordered from service.

Recommendations

In accordance with the provisions of Section 7 of the locomotive inspection act the following recommendations, with reasons therefor, are made for the betterment of the service:

1. All steam road locomotives should be equipped with a suitable water column to which shall be attached three gage cocks and one water glass with not less than 6 in., preferably 8 in., clear reading, and one additional water glass with not less than 6 in., preferably 8 in., clear reading, located on the left side or back head of the boiler. The water glasses are to be so located, constructed, and maintained that they will register the approximate general water level in the boiler under all conditions of service and show a corresponding level within 1 in. and be so located, constructed, and maintained that the engineer and fireman may under all conditions of service have an easy and clear view of the water in the glass from their respective and proper positions in the cab.



This piece of steel tubing was substituted for a safety-valve spring, similar to the one shown at the left, in a locomotive which later exploded

2. Cabs of all steam locomotives not equipped with front doors or windows of such size as to permit of easy exit should have a suitable stirrup or other step and a horizontal handhold on each side, approximately the full length of the cab, which will enable the enginemen to go from the cab to the running board in front of it—handholds and steps or stirrups to be securely attached with bolts or rivets; the distance between the step and handhold to be not less than 60 in. nor more than 72 in.

3. All steam locomotives should be equipped with a brake-pipe valve, similar to the conductor's valve used in passenger-train cars and caboose cars, at the rear of the cab or the front end of the tender, to enable the brakes to be applied in the event the enginemen are, from any cause, prevented from applying the brakes in the usual manner.

4. The condemning limit for slid flat spots on wheels 36 in. or less in diameter on road locomotives should be reduced to 1 in., and such wheels should not be continued in service if out of round $\frac{1}{16}$ in. or more in an arc having a length of 12 in. Pounds and vibrations set up by flat spots and wheels out of round cause loosening and failure of truck parts and are destructive to other parts of equipment and track, especially under present-day operating conditions when the speed of practically all trains has been greatly increased.

5. Safety glass should be used in all front cab doors and windows and in all cab storm windows. The use of ordinary glass in the front windows and in storm windows constitutes an unnecessary hazard to enginemen and others who may be riding in the cab, as is evidenced by an increasing number of injuries caused by the breaking and shattering of glass from these windows. It is therefore recommended that installation of safety glass be made mandatory in all front cab doors and windows and in all cab storm windows.

Passenger Cars Air-Conditioned During 1937

Railroad	No. of Cars	Type of Cars	Type of System	Manufacturer	Compressor Drive	Refrigerant	Generators: No.	Generators: Capacity Kw.	Generators: Type of Drive	Generators: Type of Mounting	Storage Batteries: Make	Storage Batteries: Amp.-Hr. Capacity	Outside Power Supply*
A. T. & S. F.	2	Chair	St. ejec.	Safety C. H. & L.	.....	Water	2	4	Flat belt	Truck	Exide	850	....
	6	Chair	St. ejec.	Safety C. H. & L.	.....	Water	2	4	Flat belt	Truck	Exide	850	....
	3	Chair	St. ejec.	Safety C. H. & L.	.....	Water	1	7½	Flat belt	Body	Exide	850	....
	30	Chair	St. ejec.	Safety C. H. & L.	.....	Water	1	7½	Flat belt	Body	Exide	850	....
	4	Diners	St. ejec.	Safety C. H. & L.	.....	Water	2	4	Flat belt	Truck	Exide	850	....
	11	Diners	St. ejec.	Safety C. H. & L.	.....	Water	1	7½	Flat belt	Body	Exide	850	....
	1	Cafe-Obs.	St. ejec.	Safety C. H. & L.	.....	Water	2	4	Flat belt	Truck	Exide	850	....
	6	Comb.	St. ejec.	Safety C. H. & L.	.....	Water	1	7½	Flat belt	Body	Exide	850	....
	7	Lounge	St. ejec.	Safety C. H. & L.	.....	Water	1	7½	Flat belt	Body	Exide	850	....
	5	Sleepers	St. ejec.	Safety C. H. & L.	.....	Water	1	7½	Flat belt	Body	Exide	850	....
A. C. L.	8	Diners	Elec.-mech.	Frigidaire	Motor	Freon	2	10	Flat belt	Body	Exide	1,000	•
	16	Coaches	St. ejec.	Safety C. H. & L.	.....	.....	1	10	Flat belt	Body	Edison	600	....
	10	Diners	St. ejec.	Safety C. H. & L.	.....	.....	1	10	Flat belt	Body	9 Edison 1 Exide	600 850	....
B. & O.	11	Comb.	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Exide, Edison, Gould, K. W. and U. S. L.	1,000	....
	2	Diner	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Edison	1,000	....
	1	Obs.-Lounge	Electro-mech.	B. & O.-York	Motor	Freon	2	1-6 1-7½	Flat belt Flat belt-gear	Body	Exide	1,000	....
	1	Obs.-Lounge	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Gould	1,000	....
	2	Chair	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Exide and Gould	1,000	....
	3	Buffet-coach	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	2 Exide 1 Gould	1,000	....
	77	Coaches	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Exide, Edison, Gould, K. W., Philco and U. S. L.	1,000	....
B. & M.	20	Coaches	Electro-mech.	General Electric	Motor	Freon	1	20	Gear	Body	Exide	500 at 64 v.	....
	30	Coaches	Ice	Sturtevant	.....	Ice	1	4	Flat belt	Body	Edison	256	....
Can. National	50	Coaches	Ice	.....	.....	Ice	1	4 or 5	Flat belt in summer—chain in winter	Truck	Exide, Edison and Gould	600	....
	12	Cafe-chair											
	80	Sleepers											
	26	Diners											
	14	Obs.-sleepers											
	2	Club-sleepers											
Can. Nat'l. (G. T. W.)	10	Coaches	Ice	.....	.....	Ice	1	2½ or 3	Flat belt	Body	U. S. L.	350	....
Can. Pacific	67	Sleepers	Ice	.....	.....	Ice	1	5	Gear	Body	42 Gould; 25 Exide	600	....
	5	Sleepers	Ice	.....	.....	Ice	1	5	Gear	Body	Edison	595	....
	5	Buffet-lounge	Ice	.....	.....	Ice	1	5	Gear	Body	Edison	595	....
	4	Sleepers	Ice	.....	.....	Ice	1	5	Gear	Body	Edison	680	....
	2	Obs.-chair	Ice	.....	.....	Ice	1	7½	Gear	Body	Gould	600	....
	32	Diners	Ice	.....	.....	Ice	1	7½	Gear	Body	Edison	595	....
	5	Business	Ice	.....	.....	Ice	1	7½	Gear	Body	3 Edison 2 Edison	595 1,190	....
	13	Cafe-chair	Ice	.....	.....	Ice	1	5	Gear	Body	Gould	600	....
	1	Cafe-chair	Ice	.....	.....	Ice	1	7½	Gear	Body	Gould	600	....
	8	Chair	Ice	.....	.....	Ice	1	5	Gear	Body	Gould	600	....
	22	Sleepers	Ice	.....	.....	Ice	1	7½	Gear	Body	Edison	600	....
Cen. of Georgia	30	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	Flat belt	Body	17 Edison; 13 Exide	850	....
	3	Comb.	St. ejec.	Safety C. H. & L.	.....	Water	1	10	Flat belt	Body	Edison	680	....
	1	Business	Ice	Safety C. H. & L.-A. C. F.	.....	Ice	2	4	Flat belt	Body	Edison	1,190	....
Central R. R. of N. J.	1	Cafe	Electro-mech.	York	Motor	Freon	1	20	Gear	Body	U. S. L.	1,000	•
	4	Coaches	Electro-mech.	York	Motor	Freon	1	20	Gear	Body	1 Edison; 3 U. S. L.	1,000	•
C. & O.	20	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	12-3 8-4	Flat belt	Body	Edison, Exide, Gould and U. S. L.	375 to 600	•
(Incl. Pere Marquette)	2	Diners	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	500	•
	32	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	8-4 24-3	Flat belt	Body	Lead and alkaline	8-500 24-350	•
	9	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V belt	Body	Exide	800	....
	2	Business	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	V belt	Body	Edison and Exide	1,000	•

* Cars marked thus are equipped for 220-volt a.c. operation at terminals.

Passenger Cars Air-Conditioned During 1937 (Continued)

Railroad	No. of Cars	Type of Cars	Type of System	Manufacturer	Compressor Drive	Refrigerant	Generators				Storage Batteries		Outside Power Supply*
							No.	Capacity Kw.	Type of Drive	Type of Mounting	Make	Amp.-Hr. Capacity	
C. & E. I.	1	Cafe-coach	Ice	Young Radiator Co.	.....	Ice	1	4	Flat belt	Body	K. W.	540	....
	9	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Body	6 Gould; 3 K. W.	900	....
	1	Comb.	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Body	Gould	900	....
C. & N. W.	23	Coaches	Mech.	Waukesha-P. S. C. M. C.	Gas engine	Freon	1	5	V-belt	Body	Exide	600	....
	23	Coaches	Mech.	Waukesha-Burgess-Trane	Gas engine	Freon	1	4	V-belt	Body	Exide	450	....
	2[1]	Lounge	Mech.	Waukesha-Burgess-Trane	Gas engine	Freon	1	4	V-belt	Body	Exide	450	....
	4	Comb.	Mech.	Waukesha-Burgess-Trane	Gas engine	Freon	1	3	V-belt	Body	Exide	450	....
	2[2]	Coaches	Mech.	Waukesha-Melcher	Gas engine	Freon	1	4	V-belt	Body	Exide	450	....
	5	Chair	Mech.	Waukesha-Burgess-Trane	Gas engine	Freon	1	4	V-belt	Body	Exide	450	....
	1	Buffet-lounge	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	.....	600	*
C. B. & Q.	2	Buffet-coach	Electro-mech.	Frigidaire	Motor	Freon	(Three 50 Kw. Diesel-engine-driven generators on each of two eight-car trains)						*
	3	Buffet-coach	Electro-mech.	Trane Co.	Motor	Freon	1	20	V-belt-gear	Body	Alkaline	1,000	*
	12	Coaches	Electro-mech.	Trane Co.	Motor	Freon	1	20	V-belt-gear	Body	Lead	1,000	*
	6	Coaches	Electro-mech.	Trane Co.	Motor	Freon	1	20	V-belt-gear	Body	Exide	1,000	*
C. M. St. P. & P.	47	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Exide	{27-850 {20-823	....
	3	Coaches	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Gould	450	....
	2	Sleepers	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Exide	850	....
	7	Sleepers	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Gould	450	....
	5	Comb.	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Exide	823	....
	7	Diners	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Exide	850	....
	4	Chair	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Exide	850	....
	2	Lounge	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Exide	850	....
	2	Business	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Exide	850	....
C. R. I. & P.	10	Coaches	Mech.	Waukesha-Trane	Gas engine	Freon	1	4	Flat belt	Body	.....	450	....
	3	Lounge	Mech.	Waukesha-Trane	Gas engine	Freon	1	4	Flat belt	Body	.....	450	....
D. & H.	1	Cafe-chair	Ice	Safety C. H. & L.	.....	Ice	..	..	.....	.....	Exide	400	....
D. L. & W.	8	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Lead	450	*
	8	Coaches	Electro-mech.	Airtemp	Motor	Freon	1	20	Gear	Body	Edison	1,000	*
	4	Coaches	Electro-mech.	Safety C. H. & L.	Motor	Freon	1	20	Gear	Body	Edison	1,000	*
	1	Buffet-lounge	Ice	Safety C. H. & L.	.....	Ice	1	7½	V-belt	Body	Lead	900	....
D. & R. G. W.	7	Coaches	Ice	Young Radiator Co.	.....	Ice	1	4	Flat belt	Body	Edison	510	....
	2	Business	Ice	Young Radiator Co.	.....	Ice	1	4	Flat belt	Truck	Exide	500	....
Erie	15	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	2	4	Flat belt	Body	Edison	675	....
	3	Diners	St. ejec.	Safety C. H. & L.	.....	Water	2	4	Flat belt	Body	Edison	750	....
Fla. East Coast	4	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	Flat belt	Body	Edison	600	....
	7	Diners	St. ejec.	Safety C. H. & L.	.....	Water	1	10	Flat belt	Body	{3 Edison {4Exide	750 882	....
Gr. Northern	7	Coaches	Ice	R. R. Co.	.....	Ice	1	4	V-belt	{6 Truck {1 Body	Exide	500	....
	12	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	7½	V-belt	Body	Exide	600	*
	2	Diners	Ice	R. R. Co.	.....	Ice	1	5	V-belt	Body	Exide	600	*
	2	Cafe-obs.	Ice	R. R. Co.	.....	Ice	1	4	V-belt	Body	Exide	600	....
	1	Business	Ice	R. R. Co.	.....	Ice	1	7½	V-belt	Body	Exide	1,000	*
G. M. & N.	4	Coaches	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	{3 Exide {1 Edison	200 300	....
	2	Sleeper-coach	Electro-mech.	A. C. F.-York	Motor	Freon	(Driven from main Diesel engine)				.....	75 at 110 v.	*
	1	Business	Mech.	Waukesha	Gas engine	Freon	2	5	Flat belt	Body	Edison	1,000	*
Ill. Cent.	1	Coach	Electro-mech.	Airtemp	Motor	Freon	1	20	Gear	Body	Lead	1,000	*
	39	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	3	V-belt	Body	{10 Edison {6 Edison {23 Lead	375 300 405	* * *
Lehigh Valley	1	Club	Electro-mech.	Airtemp	Motor	Freon	1	20	V-belt	Body	Exide	1,000	*

[1]—These cars formerly equipped with ice-activated systems.

[2]—The cars formerly equipped with axle-generator power supply for air conditioning.

Passenger Cars Air-Conditioned During 1937 (Continued)

Railroad	No. of Cars	Type of Cars	Type of System	Manufacturer	Compressor Drive	Refrigerant	Generators: No.	Generators: Capacity Kw.	Generators: Type of Drive	Generators: Type of Mounting	Storage Batteries: Make	Storage Batteries: Amp.-Hr. Capacity	Outside Power Supply*
L. & N.	80	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	Flat belt	Body	9 Edison; 37 Exide; 12 Gould; 10 Phileo; 12 K. W.; 3 U. S. L	850	...
	3	Diners	St. ejec.	Safety C. H. & L.	.....	Water	1	10	Flat belt	Body		850	....
Maine Cent.	5	Coaches	Ice	Sturtevant	.....	Ice	1	4	Flat belt	Body	Edison	340	....
M.-K.-T.	5	Chair	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt-gear	Body	.....	1,000	....
	1	Chair	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt-gear	Body	Exide	1,000	....
	3	Diners	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt-gear	Body	Exide	1,000	....
M. St. P. & S. Ste. M.	2	Sleepers	Ice	P. S. C. M. C.	.....	Ice	1	3	Flat belt	Body	Gould	600	....
Mo. Pac.	12	Comb.	Ice	R. R. Co.	.....	Ice	1	3	Flat belt	Body	Edison	375	....
	15	Comb.	Ice	R. R. Co.	.....	Ice	1	4	Flat belt	Body	Edison	375	....
	2	Coaches	Ice	R. R. Co.	.....	Ice	2	3	Flat belt	Body	Edison	600	....
	2	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt-gear	Body	Edison	750	....
	4	Coaches	Electro-mech.	Airtemp-York	Motor	Freon	1	20	V-belt-gear	Body	Edison	900	*
	4	Chair	Ice	R. R. Co.	.....	Ice	2	3	Flat belt	Body	Edison	600	*
	4	Chair	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt-gear	Body	Edison	750	....
	2	Diners	Ice	R. R. Co.	.....	Ice	2	3	Flat belt	Body	Edison	375	....
	2	Diners	Electro-mech.	Airtemp-York	Motor	Freon	1	20	V-belt-gear	Body	Edison	900	*
	1	Cafe-lounge	Electro-mech.	Airtemp-York	Motor	Freon	1	20	V-belt-gear	Body	Edison	900	*
	1	Cafe-chair	Ice	R. R. Co.	.....	Ice	2	3	Flat belt	Body	Edison	375	....
	1	Lounge	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt-gear	Body	Edison	750	....
	2	Business	Ice	R. R. Co.	.....	Ice	2	4	Flat belt	Body	Edison	750	....
N. C. & St. L.	18	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	Flat belt	Body	Edison	852	....
N. Y. C. System	10	Coaches	Electro-mech.	General Electric	Motor	Freon	1	20	Gear	Truck	K. W.		....
	12	Coaches	Electro-mech.	Airtemp	Motor	Freon	1	20	Gear	Truck	K. W.		....
	38	Coaches	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Truck	K. W., Exide	600	....
	15	Coaches	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Body	K. W., Edison	at 64 v.	....
	28	Diners	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Truck	Gould, Exide		....
	1	Business	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Truck	Exide		*
N. Y. C. & St. L.	8	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Edison	340	*
	2	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	826	*
	4	Diners	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Edison	512	*
	1	Business	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Edison	1,024	*
							1	4	V-belt	Body			
N. Y. N. H. & H.	50	Coaches	Electro-mech.	Sturtevant-Frigidaire	Motor	Freon	1	20	Gear	Body	Exide	500	*
	5	Grill	Electro-mech.	Sturtevant-Frigidaire	Motor	Freon	1	20	Gear	Body	Exide	500	*
N. & W.	22	Coaches	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Body	Edison	300 at 110 v.	*
	4	Comb.	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Body	Edison	300 at 110 v.	*
	1	Instruction	Ice	Trane	.....	Ice	(Equipped for 110 v. outside power only)						....
	2	Business	Ice	Trane	.....	Ice	1	20	Gear	Body	Exide	300 at 110 v.	....
Nor. Pac.	14	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	9 Exide, 5 Exide	600, 500	*
	2	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Gould	600	*
	3	Lounge-coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Gould	600	*
	10	Cafe-coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Exide	600	*
	1	Diner	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Exide	600	*
Pennsylvania	63	Coaches	Electro-mech.	Frigidaire	Axle and motor	Freon	1	7.6	V-belt	Body	.....	1,000	....
	8	Comb.	Electro-mech.	Frigidaire	Axle and motor	Freon	1	7.6	V-belt	Body	.....	1,000	....
	30	Diners	Electro-mech.	Frigidaire	Axle and motor	Freon	1	7.6	V-belt	Body	.....	1,000	....
	2	Cafe-coaches	Electro-mech.	Frigidaire	Axle and motor	Freon	1	7.6	V-belt	Body	.....	1,000	....
Pullman Co.	44	Sleepers	St. ejec.	Safety C. H. & L.	.....	Water	2	5	Flat belt	Body	Exide	875	....
	7	Sleeper-obs.	St. ejec.	Safety C. H. & L.	.....	Water	2	5	Flat belt	Body	Exide	875	....
	35	Sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	7½	V-belt-gear	Body	Exide	875	*
	41	Sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	V-belt	Body	Exide	620	*
	9	Cafe-lounge	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	V-belt-gear	Body	Exide	875	*
	11	Cafe-obs.-sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	V-belt-gear	Body	Exide	875	*
	6	Cafe-lounge-sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	V-belt-gear	Body	Exide	875	*
	2	Sleepers	Electro-mech.	P. S. C. M. C.	Motor	Freon	1	15	V-belt-gear	Body	Exide	1,000	*
							1	4	Flat belt				
	1	Chair	Electro-mech.	P. S. C. M. C.	Motor	Freon	1	15	V-belt-gear	Body	Exide	1,000	*
							1	4	Flat belt				
	348	Sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	550	*
	10	Sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	7½	V-belt-gear	Body	Exide	550	*
	3	Chair	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	550	*
	2	Chair	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	7½	V-belt-gear	Body	Exide	550	*
	2	Sleepers	St. ejec.	Safety C. H. & L.	.....	Water	1	4	Flat belt	Truck	Exide	850	....
	148	Sleepers	Ice	Pullman	.....	Ice	1	4	Flat belt	Body	Exide	600	....
	4	Chair	Ice	Pullman	.....	Ice	1	4	Flat belt	Body	Exide	600	....
	15	Sleepers	Electro-mech.	P. S. C. M. C.	Motor	Freon	Two streamline trains—two 300-kw., 220-v. three-phase a. c. Diesel-engine-driven generators on each train				1-Exide 710-amp.-hr. 64-v. battery at head end of each train and 1-Exide 175-amp.-hr. battery in observation car of each train		*

Passenger Cars Air-Conditioned During 1937 (Continued)

Railroad	No. of Cars	Type of Cars	Type of System	Manufacturer	Compressor Drive	Refrigerant	Generators: No.	Generators: Capacity Kw.	Generators: Type of Drive	Generators: Type of Mounting	Storage Batteries: Make	Storage Batteries: Amp.-Hr. Capacity	Outside Power Supply*
Reading	6	Coaches	Electro-mech.	General Electric	Motor	Freon	1	20	Gear	Body	Exide	1,000	•
	5	Coaches	Electro-mech.	York	Motor	Freon	1	20	Gear	Body	3 Exide, 2 K. W.	1,000	•
	1	Comb.	Electro-mech.	York	Motor	Freon	1	20	Gear	Body	K. W.	1,000	•
R. F. & P.	4	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	3	Flat belt	Body	Edison	375	•
	3	Diners	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Body	Exide	1,000	•
	1	Business	Ice	R. R. Co.	.....	Ice	1	4	Flat belt	Body	Edison	600	....
St. L.-S. F.	3	Comb.	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Exide	450	....
	3	Coaches	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Exide	450	....
	5	Coaches	Ice	R. R. Co.	.....	Ice	1	4	Flat belt	Body	2 K. W., 3 U. S. L.	500	....
	3	Coaches	Ice	R. R. Co.	.....	Ice	1	4	Flat belt	Body	2 K. W., 1 Exide	500, 450	....
	3	Buffet	Mech.	Waukesha	Gas engine	Freon	1	4	2 Flat belt 1 V-belt	Body Body	2 Exide 1 U. S. L.	450 500	....
	1	Cafe-lounge	Ice	R. R. Co.	.....	Ice	1	5	V-belt	Body	Exide	900	....
	3	Chair	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Exide	450	....
	1	Business	Ice	R. R. Co.	.....	Ice	1	4	Flat belt	Body	Exide	900	•
S. A. L.	4	Comb.	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	Gear	Body	Edison	300	•
	12	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Edison	300	•
	6	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	Gear	Body	Edison	375	•
	5	Diners	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	Flat belt	Body	Edison	375	•
	1	Business	Electro-mech.	Waukesha-Melcher	Motor	Freon	1	10	Gear	Body	Edison	900 at 110 v.	•
Southern	2	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	Flat belt	Body	Exide	600	•
Sou. Pac.	49	Coaches	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Edison	900	....
	4	Chair	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Edison	900	....
	4	Cafe	St. ejec.	Safety C. H. & L.	.....	Water	1	15	V-belt	Body	Edison	1,200	....
	2	Chair-obs.	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Edison	900	....
	2	Comb.	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Edison	300	....
	2	Diners	St. ejec.	Safety C. H. & L.	.....	Water	1	15	V-belt	Body	Edison	1,200	....
	2	Buffet	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt	Truck	Edison	1,200	....
	2	Diner-lounge	St. ejec.	Safety C. H. & L.	.....	Water	1	15	V-belt	Body	Edison	1,200	....
	22	Lounge	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Edison	600	....
	21	Diners	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Edison	450	....
	21	Coaches	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Edison	375 or 600	....
	6	Business	Mech.	Waukesha	Gas engine	Freon	1	7½	V-belt	Truck	Edison	750	....
	2	Cafe-lounge	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Edison	600	....
	2	Assembly	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Edison	600	....
Tex. & Pac.	1	Lounge	St. ejec.	Safety C. H. & L.	.....	Water	1	10	V-belt-gear	Body	Edison	900	....
	2	Diner-obs.	Mech.	Waukesha-Sturtevant	Gas engine	Freon	1	10	V-belt-gear	Body	Edison	900	....
	1	Diner	Mech.	Waukesha-Sturtevant	Gas engine	Freon	1	10	V-belt-gear	Body	Edison	900	....
Union Pac.	40	Chair	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	Exide	500	•
	17	Chair	St. ejec.	Safety C. H. & L.	.....	Water	2	5	Flat belt	Body	Exide	1,000	....
	5	Cafe-lounge	Electro-mech.	Airtemp	Motor	Freon	1	20	V-belt-gear	Body	Exide	1,000	•
	4	Diners	Electro-mech.	Airtemp	Motor	Freon	1	20	V-belt-gear	Body	Exide	1,000	•
	8	Diners	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	Exide	500	•
	5	Sleeper-chair	Mech.	Waukesha	Gas engine	Freon	1	5	Flat belt	Body	Exide	500	....
	5	Kitchen	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	Exide	500	•
	3	Lounge	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	Exide	500	•
	9	Lounge	St. ejec.	Safety C. H. & L.	.....	Water	2	5	Flat belt	Body	Exide	1,000	....
	1	Business	Mech.	Waukesha	Gas engine	Freon	1	10	V-belt	Truck	Exide	1,000	....
Wabash	18	Coaches	Ice	R. R. Co.	.....	Ice	1	3	Flat belt	Body	Edison, Exide, K. W. and Philco	350 and 500	....
	2	Business	Ice	R. R. Co.	.....	Ice	1	4	Flat belt	Body	Edison	1,000	....

Summary of Cars Air Conditioned During 1937

	Number of Cars	Type of Car							Type of System				Refrigerant Used		
		Coach	Combination	Dining (Note A)	Chair (Note B)	Observation	Sleeping (Note C)	Business	Electro-Mech.	Direct Mech.	Ice	Steam Ejector	Freon	Water	Ice
Alton	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
A. T. & S. F.	75	...	6	16	48	...	5	...	...	...	...	75	...	75	...
A. C. L.	34	16	...	18	...	...	...	...	8	...	...	26	8	26	...
B. & O.	97	77	11	5	4	...	...	...	97	...	...	...	97	...	...
B. & M.	50	50	...	...	...	...	...	...	20	...	30	...	20	...	30
Can. National	194	60	...	38	...	...	96	...	...	...	194	...	...	...	194
Can. Pacific	164	...	...	51	8	2	98	5	...	...	164	...	...	...	164
Cen. of Ga.	34	30	3	...	...	...	...	1	...	...	1	33	...	33	1
C. R. R. of N. J.	5	4	...	1	...	...	...	...	5	...	...	...	5	...	...
C. & O.	65	61	...	2	...	...	...	2	...	56	...	9	56	9	...
C. & E. I.	11	9	1	1	...	...	...	...	...	...	1	10	...	10	1
C. & N. W.	56	46	4	1	5	...	...	...	...	56	...	...	56	...	...
C. B. & Q.	23	18	...	5	...	...	...	...	23	...	...	...	23	...	...
C. M., St. P. & P.	79	50	5	7	6	...	9	2	...	12	...	67	12	67	...
C. R. I. & P.	13	10	...	...	3	...	...	...	...	13	...	...	13	...	...
D. & H.	1	...	...	1	...	...	...	...	...	...	1	...	...	...	1
D. L. & W.	21	20	...	1	...	...	...	...	12	8	1	...	20	...	1
D. & R. G. W.	9	7	...	...	...	...	...	2	...	...	9	...	...	...	9
Erie	18	15	...	3	...	...	...	...	...	...	...	18	...	18	...
Fla. E. C.	11	4	...	7	...	...	...	...	...	...	...	11	...	11	...
Gr. Nor.	24	19	...	4	...	...	...	1	...	12	12	...	12	...	12
G. M. & N.	7	4	...	...	...	...	2	1	2	5	...	...	7	...	...
Ill. Cent.	40	40	...	...	...	...	...	...	1	39	...	...	40	...	...
Leh. Val.	1	...	...	...	1	...	...	...	1	...	...	...	1	...	...
L. & N.	83	80	...	3	...	...	...	...	...	...	...	83	...	83	...
Me. Cen.	5	5	...	...	...	...	...	...	...	...	5	...	...	...	5
M.-K.-T.	9	...	...	3	6	...	...	...	...	...	...	9	...	9	...
M., St. P. & S. Ste. M.	2	...	...	...	...	...	2	...	...	...	2	...	...	...	2
Mo. Pac.	42	8	17	6	9	...	...	2	7	...	28	7	7	7	28
N. C. & St. L.	18	18	...	...	...	...	...	...	...	...	...	18	...	18	...
N. Y. C. System	104	75	...	28	...	...	...	1	104	...	...	...	104	...	...
N. Y. C. & St. L.	15	10	...	4	...	...	...	1	...	15	...	...	15	...	...
N. Y., N. H & H.	55	50	...	5	...	...	...	...	55	...	...	...	55	...	...
N. & W.	29	22	4	...	...	...	...	3	26	...	3	...	26	...	3
Nor. Pac.	30	19	...	11	...	...	...	...	...	30	...	...	30	...	...
Penna.	103	63	8	32	...	...	...	...	103	...	...	...	103	...	...
Pullman Co.	688	...	...	9	10	...	669	...	18	617	...	53	635	53	...
Reading	12	11	1	...	...	...	...	...	12	...	...	...	12	...	...
R. F. & P.	8	4	...	3	...	...	...	1	3	4	1	...	7	...	1
St. L.-S. F.	22	11	3	4	3	...	...	1	...	12	10	...	12	...	10
S. A. L.	28	18	4	5	...	...	...	1	1	27	...	...	28	...	...
Southern	2	2	...	...	...	...	...	...	...	...	...	2	...	2	...
Sou. Pac.	141	70	2	33	28	...	...	8	...	74	...	67	74	67	...
T. & P.	4	...	...	3	1	...	...	...	...	3	...	1	3	1	...
Un. Pac.	97	...	...	22	69	...	5	1	9	62	...	26	71	26	...
Wabash	20	18	...	...	...	...	...	2	...	...	20	...	...	...	20
Western Pac.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	2,549	1,024	69	332	201	2	886	35	507	1,045	482	515	1,552	515	482

Note A—Includes lounge-diners, coach-diners, cafe-chair, cafe-coach, kitchen-coach and buffet cars.
Note B—Includes lounge-chair, coach-chair and observation-chair cars.
Note C—Includes lounge- and observation-sleepers.

Eight-Year Summary of Air-Conditioned Cars

	Total Cars		Type of Car							Type of System				Type of Refrigerant			
	Dec. 31, 1936	Dec. 31, 1937	Coaches	Comb.	Dining (Note 1)	Chair (Note 2)	Observ.	Sleeping (Note 3)	Business	Electro-Mech.	Direct Mech.	Ice	Steam Ejector	Freon	Water	Ice	Other Refrigerants
Alton	25	25	4	4	9	6	2	...	...	25	...	...	...	24	...	...	1
A. T. & S. F.	187	262	26	6	65	142	18	5	...	1	...	...	261	...	261	...	1
A. C. L.	75	109	81	...	28	...	...	...	...	11	...	...	98	11	98	...	...
B. & O.	275	372	240	55	59	8	8	...	2	372	...	...	...	372	...	...	...
B. & M.	43	93	85	4	4	...	...	...	...	33	...	60	...	33	...	60	...
Can. National	56	250	60	...	41	27	...	122	...	...	...	250	...	...	...	250	...
Can. Pacific	141	305	8	4	56	14	6	212	5	2	7	295	1	9	1	295	...
Cen. of Ga.	13	47	41	3	2	...	...	...	1	...	...	1	46	...	46	1	...
C. R. R. of N. J.	18	23	17	2	4	...	...	...	...	23	...	...	...	23	...	...	...
C. & O. (Incl. Pere Marquette)	52	117	92	4	14	...	...	...	7	...	108	...	9	108	9	...	...
C. & E. I.	20	31	20	3	8	...	...	...	...	...	...	6	25	...	25	6	...
C. & N. W.	150	206	121	14	41	20	10	...	...	14	104	88	...	104	...	88	14
C. B. & Q.	133	156	61	...	43	39	5	8	...	118	4	34	...	122	...	34	...
C. M., St. P. & P.	163	242	105	5	35	29	4	62	2	...	14	...	228	14	228	...	...
C. R. I. & P.	119	132	59	4	31	34	4	...	...	...	15	105	12	15	12	105	...
D. & H.	5	6	...	...	6	...	...	...	...	...	...	6	...	...	...	6	...
D. L. & W.	33	54	40	...	12	...	1	...	1	17	23	14	...	40	...	14	...
D. & R. G. W.	40	49	28	...	12	...	7	...	2	...	...	49	...	...	...	49	...
Erie	22	40	30	...	7	...	...	...	3	1	...	...	39	1	39	...	...
Fla. E. C.	32	43	30	...	13	...	...	...	...	...	...	...	43	...	43	...	...
Gr. Nor.	37	61	35	...	24	...	...	...	2	...	12	49	...	12	...	49	...
G. M. & N.	5	12	5	...	2	...	...	4	1	7	5	...	...	12	...	...	...
Ill. Cent.	120	160	99	10	35	10	2	...	4	12	135	13	...	147	...	13	...
Leh. Val.	14	15	4	...	7	4	...	...	...	15	...	...	...	15	...	...	...
L. & N.	52	135	119	...	16	...	...	...	...	...	...	...	135	...	135	...	...
Me. Cen.	12	17	15	2	...	...	...	...	...	...	...	17	...	...	...	17	...
M.-K.-T.	17	26	...	...	12	9	4	...	1	6	...	3	17	3	17	3	3
M., St. P. & S. Ste. M.	7	9	...	...	3	...	4	2	...	...	7	2	...	7	...	2	...
Mo. Pac.	303	345	132	33	102	62	5	...	11	43	1	239	62	43	62	239	1
N. C. & St. L.	13	31	25	...	6	...	...	...	...	...	...	...	31	...	31	...	...
N. Y. C. System	208	312	181	1	126	2	1	...	1	239	58	15	...	297	...	15	...
N. Y. C. & St. L.	6	21	15	...	4	...	...	...	2	...	21	...	...	21	...	...	...
N. Y., N. H. & H.	332	387	329	17	35	2	4	...	...	254	...	133	...	254	...	133	...
N. & W.	91	120	84	19	11	...	...	...	6	110	...	6	4	110	4	6	...
Nor. Pac.	53	83	39	...	28	2	14	...	...	...	83	...	...	83	...	...	...
Penna.	502	605	351	103	151	...	...	...	...	185	...	419	1	184	1	419	1
Pullman Co.	4,151	4,839	...	...	9	391	494	3,945	...	187	2,920	1,352	380	3,107	380	1,352	...
Reading	46	58	39	11	8	...	...	...	...	58	...	...	...	58	...	...	...
R. F. & P.	17	25	14	2	8	...	...	...	1	13	9	1	2	22	2	1	...
St. L.-S. F.	85	107	50	5	25	17	5	2	3	...	13	94	...	13	...	94	...
S. A. L.	67	95	47	17	27	...	...	...	4	4	91	...	...	95	...	...	...
Southern	34	36	2	...	34	...	...	...	...	...	...	...	36	...	36	...	...
Sou. Pac.	259	400	169	2	103	114	4	...	8	...	100	225	75	100	75	225	...
T. & P.	57	61	39	...	12	5	3	...	2	1	9	21	30	10	30	21	...
Un. Pac.	221	318	63	...	83	129	37	5	1	26	228	...	64	254	64	...	...
Wabash	46	66	41	...	18	4	...	...	3	...	...	66	...	...	...	66	...
Western Pac.	15	15	7	...	5	...	3	...	...	...	3	...	12	3	12	...	...
Total	8,372	10,921	3,052	330	1,384	1,070	645	4,367	73	1,777	3,970[4]	3,563	1,611	5,720	1,611	3,563	21

Note 1—Includes lounge-diners, coach-diners, cafe-chair, cafe-coach, kitchen-coach and buffet cars.
Note 2—Includes lounge-chair, coach-chair and observation-chair cars.
Note 3—Includes lounge- and observation-sleepers.
Note 4—Includes 250 cars on which the compressor is driven by a gas engine.

EDITORIALS

The Height Of Luxury

The Victorian Railways (Australia) recently completed a streamlined, air-conditioned, steam-locomotive-propelled train, "The Spirit of Progress," in their workshops at Newport, which will make a non-stop run of about 190 miles between Melbourne, over the border of New South Wales to Albury. It will accommodate more than 400 passengers and seems to be comparable with the streamlined trains operating in this country; it will make an average speed of about 50 miles an hour, touching 70 miles an hour on those sections of the track on which such speeds are permissible.

Apparently it is luxurious not only for the traveler, but for the trainmen as well. The Argus, a Melbourne newspaper, under the caption of "The Guard Will Have a Periscope," publishes this item: "How many small boys have reveled in the opportunity of sitting in the high perch of an ordinary guard's van, from which the guard watches the signals ahead! For the guard, the novelty of the position soon wears off and many will envy the guard of the new train. He sits in his chair in the proper place for a chair to be —on the floor. High above him a window provides a view along the whole of the top of the train to the signals ahead, and he watches the scene reflected in a mirror set comfortably in front of him. A second sloping mirror, in front of the upper window, completes the guard's periscope."

In this country the engineer and fireman have the sole responsibility for watching for the signals ahead; their task is simplified on some roads, and particularly in bad weather, by the use of cab signals. The brakeman on the rear end of the high-speed trains is unusually concerned with keeping track of what goes on behind or alongside the train. On one road, all employees along the right-of-way are ordered to watch the high-speed trains critically as they pass and to indicate to the brakeman by proper acknowledgment if all is right, or if something is at fault. This brakeman sits in a chair—on the floor—but his duties are more exacting—and possibly more productive—than those of the periscope attendant.

The Victorian Railways officers and employees are proud of the fact that the interior paneling of the cars in the new train is made from the most beautiful of Australian timbers, the sheets for each compartment being carefully graded. It is said that not one of the thousands of these panels, which were trimmed, fitted and polished at the company workshops, was damaged in any way.

Another item of interest to American railroaders is the fact that the baggage racks have rubber-covered front bars, to prevent the baggage from slipping.

The rapidly extending use and development of high-speed passenger trains throughout the world promises to bring about more and more improvements and conveniences, which will lure business away from competing types of carriers and back to the rails. Incidentally the railroads of the United States are not alone in suffering from such competition.

Useless Waste

The author of the paragraph captioned "Importance of Using Standard Specifications" on the Gleanings page of this issue, could have placed even stronger emphasis on the advisability of using standard specifications. It, of course, does not cost the railroad company directly very much to print its own individual sets of specifications, but their use places a heavy expense on the railway supply companies, and this of necessity will be reflected back in the higher prices which they must ask for their products.

It would be difficult to estimate accurately this added cost, but the engineering departments of those companies which manufacture basic materials and supplies can give concrete evidence of the great amount of extra work to which they are put, where the different railway companies insist on their own individual specifications, differing only in certain details from standard specifications which have been adopted and approved of by the Association of American Railroads, or the American Society for Testing Materials. Company specifications must be checked with great care against the standard specifications, and obviously higher prices must be asked for those materials which deviate far enough from the standard specifications to necessitate special effort and handling to conform to them. Even though this may not be necessary, the cost of checking the specifications in the engineering department and the details involved in dealing with the sales and production departments, makes for a very considerable added expense in many instances.

While there may be occasions when such deviations are advisable, there is no question but that some railroads can make large savings, directly and indirectly, by conforming to the standard specifications and designating them in asking for prices. This is one form of waste which should not be condoned.

Locomotive Smoke Elimination

The December, 1937, report of locomotive smoke performance of Hudson County, N. J., shows the very low average smoke density of 0.68. This is the result of 875 locomotive stack observations on the nine railroads which operate in that county. Four of the roads, the New York Central, the Lehigh Valley, the Reading and the New York, Ontario & Western, had a perfect record—0.00. This is the result of a number of years of continued and persistent effort on the part of the Department of Smoke Regulation of Hudson County, and with the hearty co-operation of the Railroad Smoke Association and the railway organizations supporting it.

No approach to the problem has been left uncovered. As an illustration, the December meeting of the association was featured by an address on Locomotive Maintenance in Relation to Smoke, by Superintendent Motive Power and Rolling Stock, A. K. Galloway, of the Jersey Central and Reading. James Partington of the American Locomotive Company, addressed the January meeting on Improvements in Design Tending to Better Smoke Performance in Locomotives. In like manner, almost every phase of railroad operation which is in any way concerned with the efficient combustion of fuel and smoke prevention has been painstakingly studied and discussed during recent years.

The Smoke Association meets monthly, the sessions lasting for two hours from 2:00 p. m. to 4:00 p. m. This allows ample time for discussion after the address. As a result, there has been a steady decrease in the volume of locomotive smoke during the several years that the movement has been under way. The attitude of the railroads and the results which have been secured through their co-operation, have not only been appreciated by the public, but have stimulated other groups to make similar efforts. A Marine Association, for instance, has been functioning almost as long as the Railroad Association, and more recently a strong association has been organized by the industries in Hudson County. The railroads are to be congratulated for the lead that they have taken in this movement.

Fuel Costs Are Up

As a result of new wage agreements and the National Bituminous Coal Act designed to regulate prices and trade practices, railroads are unquestionably faced with a substantial advance in the cost of coal, especially that used in locomotive service. In fact, it is estimated that new prices already in effect will increase railroad coal costs by more than $19,000,000 during the present year. This means that railroad mechanical officers have the definite responsibility of redoubling their efforts in the interest of fuel economy, which means keeping motive power in the best operating condition practicable and rechecking all of the hundred and one details of locomotive construction and operating practice which have a bearing on fuel performance.

An example of the present trend towards increased fuel costs is afforded by figures issued by the I. C. C., Bureau of Statistics, the latest figures available being for November, 1937, as compared to November, 1936. During this 12-month period pounds of coal per 1,000 gross ton-miles decreased from 123 to 122, or 0.81 per cent, and pounds of coal per passenger train car-mile decreased from 15.7 to 15.5, or 1.27 per cent. During the same period the cost of fuel per 1,000 gross ton-miles increased from 15.85 to 16.85 cents or 6.30 per cent, and the cost of fuel per passenger train car mile increased from 2.02 to 2.14 cents, or 5.94 per cent. The average cost of fuel per equated ton mile (coal equivalent) increased from $2.58 in November, 1936, to $2.76 in November, 1937, or 6.98 per cent.

In other words, in spite of a slightly more efficient use of fuel in November, 1937, the cost per unit of work done increased about 6 per cent on the average due to increased cost of coal at the mines. The Railway Fuel & Traveling Engineers' Association is taking steps to bring these facts to the attention of railroad men generally, a worthy effort which this publication is glad to support and supplement wherever possible.

The increased costs of railway fuel on a ton basis for coal and a barrel basis for oil are largely out of the control of railroad men. Much can be done, however, to reduce the total amount of the fuel bill by avoiding the unfortunate cumulative effect of inefficient practices combined with high-purchase price. It is particularly important, for example, to re-check fuel saving devices, not previously installed because of apparent high first cost, but which now are amply justified by the savings possible when high-priced fuel is used.

The effective fuel conservation efforts of railroad mechanical department officers working on their own individual roads and through an aggressive specialized group like the Railway Fuel & Traveling Engineers' Association were never more needed nor potentially productive in saving railroad fuel money, than today.

The Correct Cutting Fluid

In a machine shop one often sees all drilling, cutting, milling and grinding operations being performed with the same cutting fluid. This raises the question: How much consideration are men responsible for the recommendation and purchase of cutting fluids giving to the length of tool life in machining operations as effected by cutting fluids?

Information is available from various sources showing that the proper cutting fluid can be ascertained

only through extensive tests of the various machining operations. For example, it has been determined, when machining S. A. E. 3140 steel with 18-4-1 high-speed tools and using a feed of 0.0125 in. and a cut of 0.1 in. deep, that a tool life of two hours can be maintained (1) at a cutting speed of 83 ft. per min. when cutting dry; (2) at a cutting speed of 89 ft. per min. with plain mineral oil; (3) at 93 ft. per min. with emulsion of one part oil and 16 parts water; (4) at 97 ft. per min. with a sulpherized mineral oil; (5) at 100 ft. per min. with 0.153 per cent by weight of colloidal graphite added to the 1-16 emulsion; and (6) at 106 ft. per min. when cutting with 0.153 per cent by weight of colloidal graphite added to mineral oil. At a uniform cutting speed the five cutting fluids mentioned would give a progressively increasing tool life.

To give another example, it has been found that the life of a tungsten-steel blade in a motor-driven saw will vary with the cutting fluid used. Practically all cutting fluids show an increase in cutting time per piece as production increases, but the rate of increase of cutting time varies with the type of cutting fluid used. Usually, a sulpherized lard oil blended with small parts of mineral oil will show the greatest economy in regard to the life of the saw blade when cutting ferrous materials, although the cutting time per piece, when the blade is new, may be slightly lower than when other cutting fluids are used.

Many shops can well afford to investigate the results of tests offered by those who produce such cutting fluids and by individual disinterested investigators in this field. Although the two examples given herein in no way attempt to summarize the extended research in this field, they do suggest that real economy in machining operations can be effected by the selection of the cutting fluid which will produce either the best quality or the greatest production, or both. Some of the cutting fluids mentioned herein may not be the cheapest available, but because they have peculiar characteristics which certainly affect tool life advantageously they cannot be selected on a price basis alone. Accurate tests of machining operations with various cutting fluids is the one best means to that end.

New Books

THE RAILWAY CARRIAGE & WAGON HANDBOOK. *Published by The Locomotive Publishing Co., Ltd., 3 Amen Corner, London, E. C. 4. 366 pages, 5 in. by 7 in., cloth bound. Price, $1.*

General principles underlying British practice, rather than individual practices, are dealt with in this handbook. Both wood-framed and all-steel passenger-car bodies—floors, roofs, ceilings, interior finish, timber, etc.—are discussed in Chapter 1. Separate chapters are devoted also to painting; the passenger-car underframe; trucks; freight-car design; buffers and draft gear; wheels; mass production of freight cars; progressive repairs; inspection; lightweight in coach construction; interior metal work and its decorative treatment, and railway gages. British standard specifications for materials are then presented.

TRAVELING ENGINEERS EXAMINATION BOOK. *Prepared and published by the Railway Fuel and Traveling Engineers' Association, Old Colony building, Chicago. 256 pages. Bound in cloth. Price of individual copies $1.50, with suitable percentage reductions for quantity orders.*

This 1937 revision of the book formerly issued by the Traveling Engineers' Association has been brought up to date and now contains more than 1,200 questions and answers relating to the locomotive and its operation, as well as such accessories as stokers, boosters, reverse gears, superheaters, mechanical lubrication, feedwater heaters and the latest type of air brakes.

SMOKE AND BOILER ORDINANCES. *Manual compiled and published for the Smoke Prevention Association, Secretary Frank A. Chambers, Room 1001 City Hall, Chicago. 152 pages, 6 in. by 9 in. Price: Paper bound 50 cents.*

This manual of smoke and boiler ordinances and requirements is published in the interest of smoke and air pollution regulation and increased efficiency in fuel combustion. It is the official publication of the Smoke Prevention Association and includes, in addition to recommended methods for measuring air pollution, a synopsis of papers read before the thirty-first annual convention held at New York, June 1 to 4, 1937. Of particular interest to railroad men are the papers on "Locomotive Smoke Abatement", by E. E. Ramey, fuel supervisor, Baltimore & Ohio; and "What the Railroads Have Done to Abate Smoke in Hudson County, N. J.", by George H. Massey, Hudson County, N. J.

SMOLEY'S SEGMENTAL FUNCTIONS — TEXT AND TABLES. *Published by C. K. Smoley and Sons, Scranton, Pa. 186 pages, 4½ in. by 7 in. Leather bound. Price, $5.*

Simple methods of solving a circular segment and of computing its area, when the segment is given with any two of its five parts—viz., the arc, the chord, the radius, the central angle and the height—with numerous examples illustrating the application of these methods are contained in this book by C. K. Smoley. Since the publication of his book "Parallel Tables of Logarithms and Squares of Feet, Inches and Fractions of an Inch" in 1901 the author has continually received requests from engineers and architects for a book which could be used in combination with that book in solving problems dealing with parts of a circular segment. With that aim in view he conceived the idea of accomplishing for the solution of the circular segment what the trigonometric functions had done for the solution of the triangle; hence, the introduction of segmental functions in the present book.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Ways of Wasting Locomotive Fuel

Fuel conservation is a matter of continual discussion on all railroads. As a rule the subject is approached from the standpoint of saving fuel. Why not stress wasting fuel? Here is a question I should like to propound. How many ways can you enumerate of wasting fuel on a locomotive? I have in mind an up-to-date design, equipped with stoker, booster, feedwater heater, etc.

Importance of Using Standard Specifications

Material specifications have for years been individual on a large number of roads. For all basic materials, rails, tires, axles, plates, etc., all essentials are identical. A single A. A. R. or A. S. T. M. specification would secure the same quality of material. The practice of each railroad printing and issuing its own specification seems unnecessary. The expense involved in frequent reissues and in distribution to all interested departments as well as to the concerns which may bid on this material, has seemed to be a practice which has really outgrown its usefulness. It is easily understood that mechanical and test departments like to have a specific document bearing the railway company's heading. This practice was fully justified when it originated at a time when there was no American Society of Testing Materials, nor was there a unified railway organization which concerned itself energetically in the preparation of specifications and in their regular revision as the state of the art developed. In the writer's opinion the abandonment of specific railroad specifications, and an earnest desire to use A. S. T. M. or A. A. R. specifications for generally used material, offers the possibility of considerable saving.

Goals to Shoot At

At one time a number of years ago—back in the early 20's, I think it was—it was the practice on many railroads to establish goals or objectives toward which to strive, in the effort to improve the efficiency and effectiveness of a department or of operations as a whole. One division would compete with another, or one shop or department with another, thus stimulating a keen interest in better performance throughout the departments, or through the entire railway organization. Unless I am mistaken, there is not much of this being done at the present time. Obviously it must have paid, and paid well, in promoting economies and increasing efficiency of operation. Why don't you advocate starting something of this sort today? Incidentally, I can recall the time when in the effort to promote shop efficiency, your own magazine staged frequent competitions for the best shop kinks or the best methods of performing certain operations. Has the depression hit us so hard that our spirit and our sportsmanship have been lowered or reduced to a point where we have become insensible to such appeals? Except for safety competitions, which have become more or less routine, can you name other types of competitions in the mechanical departments of our railroads?

Departmental Safety Meetings

How many railroads have monthly departmental meetings with the men and the foremen? Many manufacturing concerns follow such practice. It gives the foremen an opportunity to cultivate friendly relations with the employees and permits misunderstandings as to rules and regulations to be cleared up. Production problems are also discussed, but safety should be the main topic of discussion. The supervisor in charge of such meetings should take special pains to see that they are not only instructional, but are so interesting that the men will want to attend them.

Eyes That Do Not See

It ought not to be necessary to have an outsider come in and tell us how to do our job better, and yet, what a jar we sometimes get when such a person questions about why we do a certain thing in a certain way. We have an operation in our shop of which we felt we could be justly proud, because of the improvement which we have made as compared to former practices. The other day we were showing it to a visitor to whom the entire operation was new and unfamiliar. Imagine our dismay when he asked a simple question that almost automatically suggested a still further improvement which could be readily made to excellent advantage. Since that time I have been trying to look at and study familiar, routine jobs with a more questioning mind and critical attitude. Just why do we do a certain job in a certain way? Is there not some way of doing it more easily and inexpensively? Have conditions changed since the method or practice was first inaugurated, which might well warrant making an entire restudy of the operation or the method of handling?

Trains Still Fascinate Public

Enjoying a monopoly of the transportation field for so many years, the railroads formerly had little or no incentive to cultivate public interest and good-will, and some of them made but a feeble effort to cultivate either. There is, therefore, good reason for amazement at the sustained interest which the general public unquestionably exhibits toward all things connected with the operation of railroads. My working hours are spent at a large industrial plant, so situated that it affords a clear view of every form of transportation—steam trains, motor vehicles, military and commercial airplanes, and, until recently, multiple unit electric cars. Though not unusual so far as my observation goes, the difference in the reaction of the workingmen to the passage of these various transport units is worthy of notice. Large buses or motor trucks rarely draw a glance; airplanes, if in deafening formations of a half dozen or more, may evoke some slight interest; but, when a fast passenger train rushes by, or a heavy freight passes with its interminable string of cars, nearly every eye is riveted on the engine for a moment. The numbers and characteristics of the engines usually seen on the various trains are well known, and the appearance of a strange engine is immediately recognized and commented upon by the men. With one exception, all these engines are of the most ordinary varieties, without any streamlining, dashes of color, or other up-to-date frills which might create unusual interest. The one exception is a 600-hp. Diesel-electric switcher, which began work very quietly a short time ago and has since caused much discussion and speculation among railroad men and others. Some of the misinformation concerning this engine, now being circulated by those who ought to know better, would gain little credence if the owners had given proper publicity to its advent.

With the Car Foremen and Inspectors

Illustrations of Journal-Bearing Troubles

Notwithstanding the importance attached to the use of proper lubricants in journal boxes of railroad equipment, it is a well-known fact that the solution of the hot-box problem lies not alone in the quality of the oil and waste. In packing the box, railroad officers who are familiar with this phase of train operation will at once agree that it is equally important to see that all the mechanical parts of the journal box are in proper order; for example, the journal and bearing, the bearing wedge, the box, the box lid and dust guard must be in good repair to insure satisfactory lubricating performance.

Frequently, the cause of a hot box is ascribed to the inferior quality of the lubricant, when upon investigation it will be found that some mechanical defect present in the journal-box assembly contributed to the failure and very likely was the primary cause of all the trouble. Often, too, the evidence is destroyed, in which case the actual cause cannot be determined. The purpose of this article is to bring to the reader's attention two major causes contributing to the hot-box problem; namely, the journal bearing and the journal-bearing wedge, and to show by illustrations some of the actual conditions recently found on cars of various ownerships while on repair tracks undergoing repairs.

Unquestionably a marked improvement has been made in the hot-box situation since the introduction of rule 66 of the A. A. R. Interchange Code. This rule sets forth a course of procedure which should be followed if the objectives sought are to be attained. It will be apparent from the accompanying illustrations that a further improvement can be effected if greater care be given to the mechanical details when cars receive periodic repacking of journal boxes. To that end we

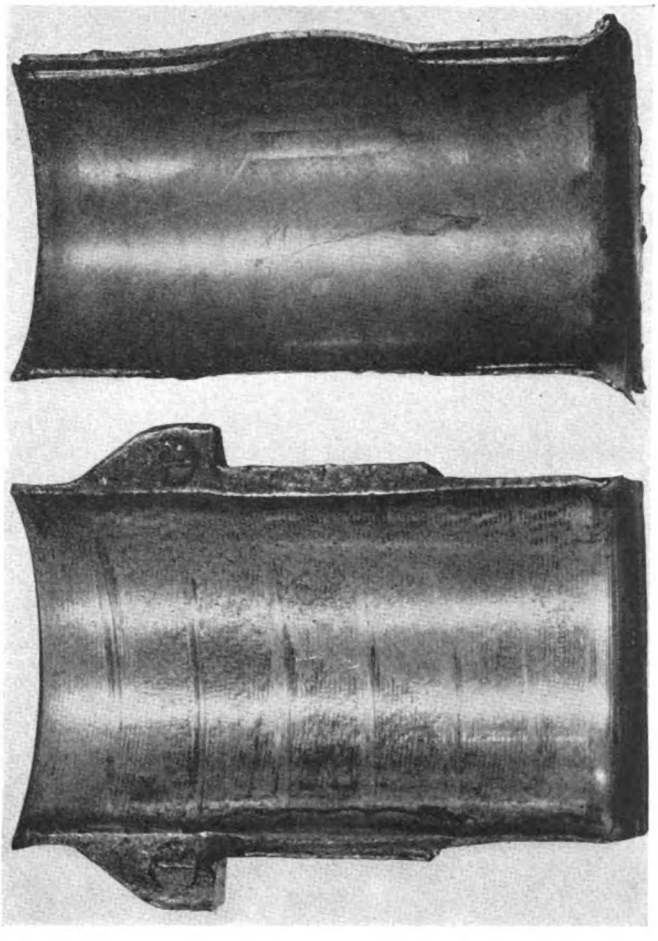


Fig. 2—The bearing metal shown at the top became loose after this second-hand bearing, unsuited to the journal diameter, had been applied

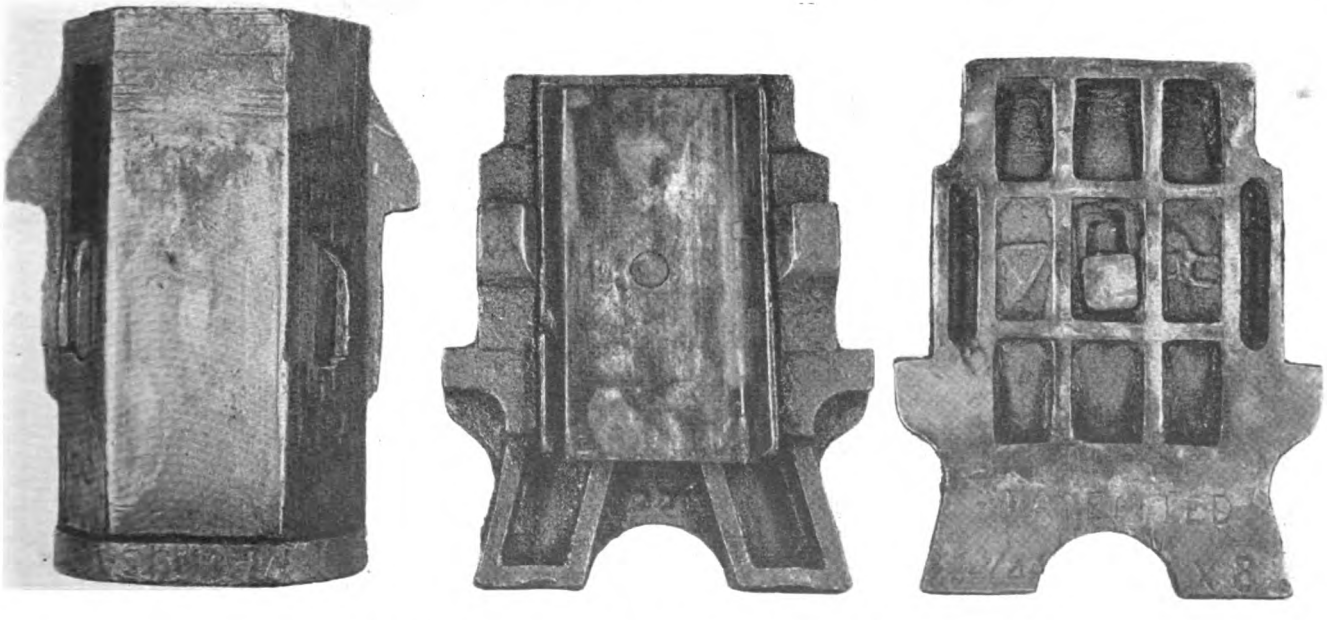


Fig. 1—An antiquated wedge that should have been discontinued in service

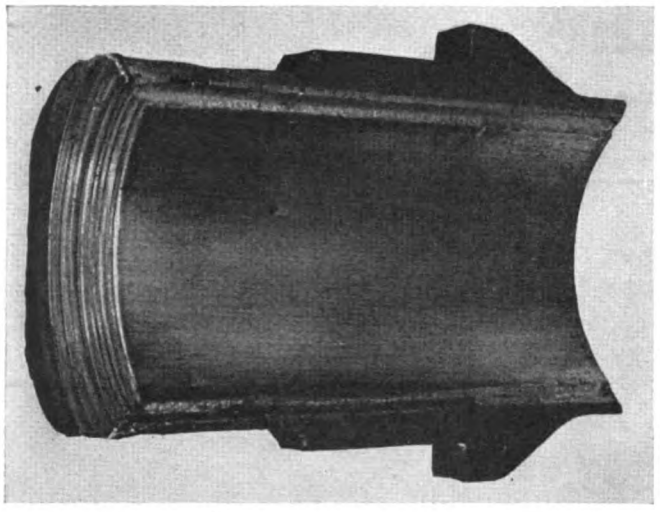


Fig. 3—A faulty journal fillet caused this bearing condition

must look to our supervision to see that rule requirements are complied with.

While this subject is not new, it is hoped that the material presented here will prove interesting and informative. Train delays are expensive and sometimes embarrassing. Such delays arising from hot boxes can be avoided, to a great extent, by proper workmanship and by using lubricants of proper quality.

Fig. 1—Do you recall this type of wedge? Some of the "old timers" will. Admittedly this wedge has seen years of service and has long since outlived its usefulness. Note the condition of the journal bearing, particularly where the sliding section wore into the back.

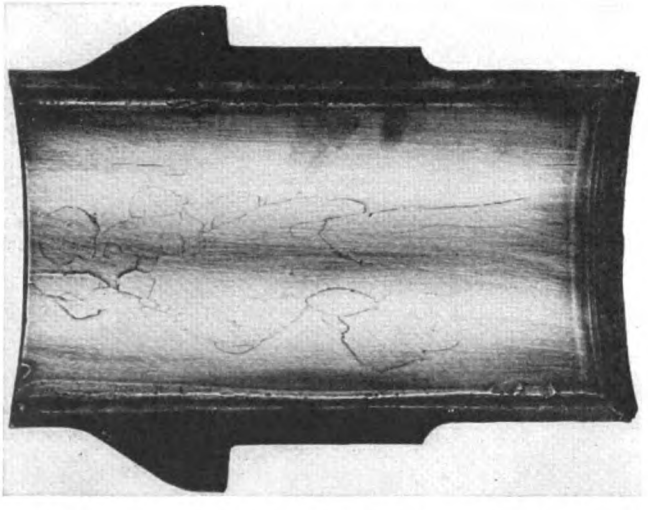


Fig. 4—Progressive cracking caused by hydraulic pressure between the lining and the shell when once a small crack appears

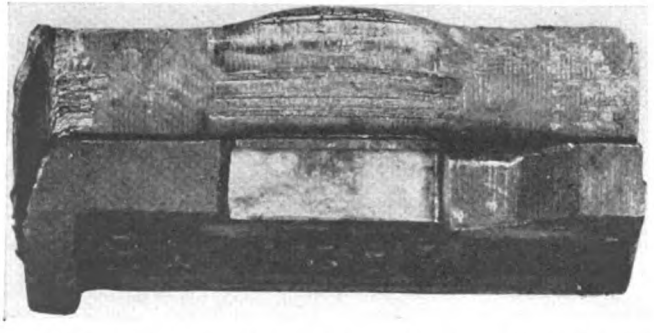


Fig. 5—A simple hammer test might have discovered this loose lining

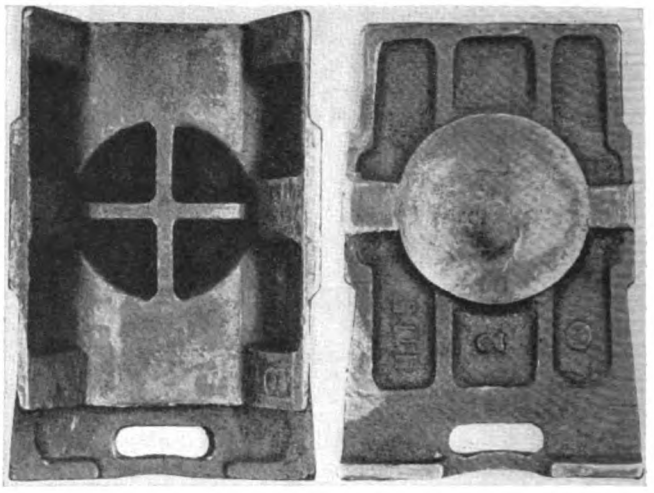


Fig. 6—Wedge of obsolete design removed recently from a car—Note the uneven bearing surface where the wedge contacted the box

One can see at a glance what caused the wear on the lugs at the inside of the wedge and the consequent pinching of the bearing and retarding of the oil flow. These were removed from a car that bore a repack stencil of recent date.

Fig. 2—This bearing was removed in a transportation yard where a wide-awake inspector had noted that the babbitt lining had slipped below the bearing shell. Apparently someone had applied a second-hand bearing unsuited to the diameter of the journal. During wheel changes it is important, when second-hand bearings are used, to caliper the journal to determine whether the bearing is of proper size. In the case of repacks it is

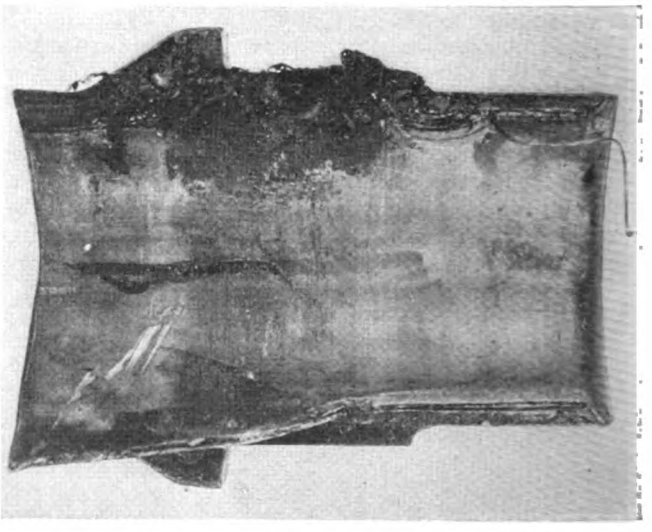


Fig. 7—The car inspector's friend—a waste grab

more economical to apply a new bearing when in doubt rather than to risk the application of a poor second-hand bearing. Note the bearing surface on the side of the shell and you will readily understand how this undersized fit affected the bearing, causing the shell to fracture at the side and the lining to crack and become loose.

Fig. 3—Except for the worn condition of the fillet end, this bearing otherwise looks like a new one. The excessive wear indicated, causes one to wonder what consideration axle fillets are receiving when axles go through the shops for attention. Perhaps it would be advisable to investigate our wheel and axle practices to ascertain whether the fillets are being properly machined.

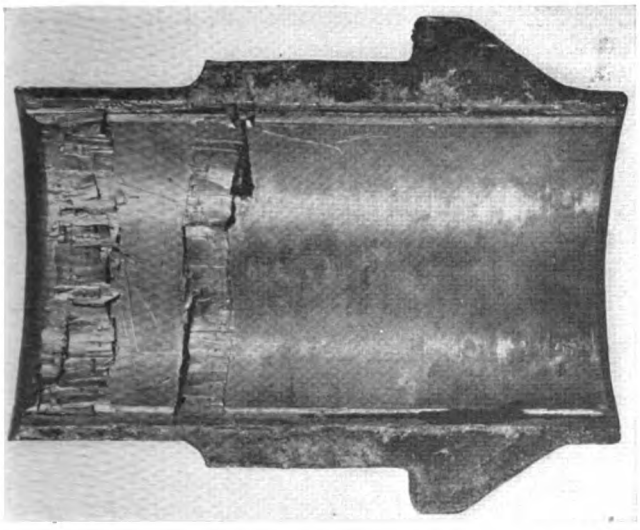


Fig. 8—Isn't this something! Two channels were chiseled in the bearing to relieve a cut-journal condition

Fig. 4—This illustration shows a badly cracked or shattered lining on a bearing removed from a car a few months after periodic repacking of boxes. A slight crack is not always visible in ordinary inspection, yet here we have a typical case of progressive cracking resulting from the hydraulic pressure exerted between the lining and shell when once a slight or small crack appears. Obviously we would be well repaid for any extra time spent in a closer inspection of bearings at the time journal boxes are repacked.

Fig. 5—Here we show another case of a loose lining.



Fig. 9—This brass was applied even though it did not fit the wedge—Evidence is shown of a cut journal

The question which arises is: In our examination are we properly testing the bearings to assure ourselves that the linings are not cracked or loose before reapplication to the box? Try the simple hammer test and see how a light tap on the back of the bearing will reveal a trace of oil in the babbitt metal if a crack is present in the lining.

Fig. 6—This wedge of obsolete design was removed from an overheated journal under a car that had been recently repacked. Note on the back of the wedge the uneven bearing surface where it contacted the ceiling of the box. A crack appears to be developing crosswise, at the front of the wedge. Do you consider that the party who applied this wedge properly inspected the mechanical details of this box assembly to insure 15 months' operation free from trouble?

Fig. 7—Here is an excellent example of a waste grab—the car inspector's "friend." The inspector may tell you it resulted from rough train handling, emergency brake application, etc., while the yard-master may claim that it was caused by overpacked boxes, or packing otherwise improperly applied. Well, any one of these opinions may be right. The fact remains that the waste grab is a common source of trouble.

Fig. 8—This is an unusual case. Various deductions can be made. The evidence indicates that the journal was found cut in two places and the repairman conceived the idea of chiseling out two channels in the babbitt to avoid contact with that portion of the journal which was cut. This box had been treated with a cooling compound which led to the car being shopped for attention with findings as indicated.

Fig. 9—Some lubricating specialists go so far as to advocate the machining of the top of journal bearings to insure a uniform surface the full length of the bearing. Here we have a case where a bearing had been applied when it was known that it would not properly contact the inner surface of the wedge. In other words, at the very outset this box had an uneven bearing. Note

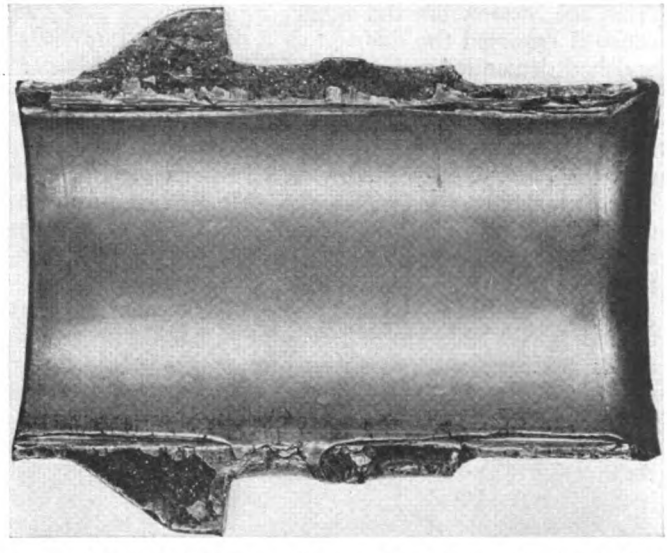


Fig. 10—Brass with lug extensions swedged in, causing the babbitt lining along the side to act as a wiper and rob the journal of its adequate supply of lubrication—An example of carelessness on the repair tracks

from the front view the varying thicknesses of the shell and lining. Yes, this was a 1937 bearing, and if you will observe closely, you will see evidence that the journal doubtless had been cut. In this case the inspector simply applied an A. A. R. defect card and allowed the car to go forward. Such practices invite serious trouble and should be discouraged. Suppose in this case the journal had burned off and extensive property loss resulted. Where would the responsibility rest?

Fig. 10—This bearing was removed when wheels were changed under a car that had been repacked two months

previously. Note where the lug extensions have been swedged in. As a result the babbitt lining along the sides will act as a wiper and rob the journal of its adequate supply of lubrication. The distance across the lug extensions originally measures 5⅝ in., whereas in this case it has been reduced by ⅜ in. This is an example of carelessness on repair tracks, in that a defective bearing was reapplied when boxes were repacked. Could we expect 12 to 15 months satisfactory lubricating performance under such conditions?

Decisions of Arbitration Cases

(The Arbitration Committee of the A.A.R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Truck-Side Damage Caused by Broken Axle

On January 28, 1935, the Wabash delivered an empty stock car, owned by the Quaker City Live Stock Express, to the Chicago and Illinois Midland with a hole worn through the top of the left No. 3 journal box. This hole was caused by the box riding on the stub of a broken journal on a pair of wheels replaced by the Wabash. The C. & I. M. ordered a new truck side from the owners but did render a bill for the part, because it reported the damage as a delivering line defect and had demanded a defect card from the Wabash.

Although the Wabash admitted the truck was damaged on its line and had replaced the wheels without making repairs to the truck side, this road contended that the damage was the owner's responsibility because such damage resulted when the axle broke, permitting the truck side to drop down and let the box ride on the axle stub. Therefore, it refused to issue a defect card to the C. & I. M.

The C. & I. M., having repaired the damage, contended that it was entitled to render a bill for repairs either against the Wabash on authority of defect card or against the car owner, depending on the result of the decision rendered by the arbitration committee.

In a decision rendered on November 12, 1936, the Arbitration Committee stated "As the defect on journal box of truck side developed due to a broken axle, owner's responsibility, the same responsibility applies to the damaged truck side."—*Case No. 1753, Chicago & Eastern Illinois Midland versus Wabash.*

Charges for Arch Bars and Tie Bars Replaced with Side Frames

On September 13, 1935, a car owned by the North American Car Corporation was derailed on the St. Louis Southwestern and was returned to the owner with the delivering line damage covered by defect cards. The arch bars and tie bars were bent, and the owner elected to scrap and replace them with Andrews side frames, charging the St. Louis Southwestern a price equivalent to that for repairing the arch bars and tie bars plus necessary material costs instead of charging for new parts. The charges made by the car owner amounted to $58.66, while the actual betterment charges amounted to $105.84.

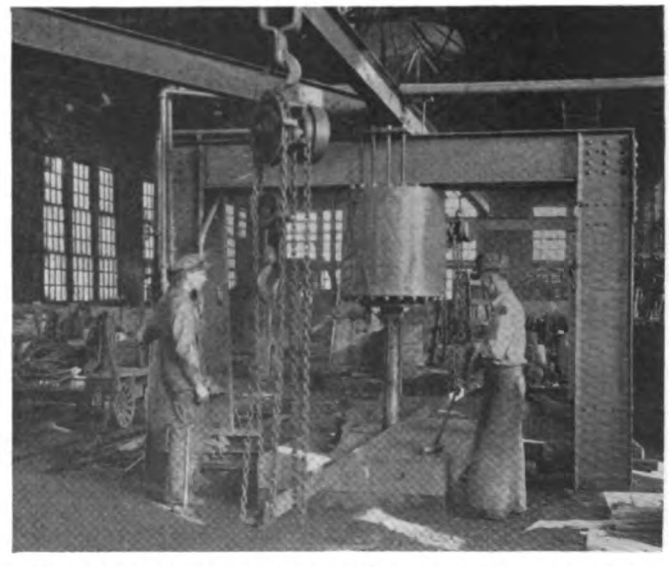
The St. Louis and Southwestern contended that the charges should be confined to the work actually performed, and that any increased cost resulting from the application of betterments was the owner's responsibility. However, the owner maintained that its charges were in accordance with the original design and did not exceed the betterments applied, which is in accordance with the first paragraph of rule 94. Consequently, the owner contended that its charges were correct.

The Arbitration Committee's decision, rendered April 8, 1937, stated: "The charge as rendered by the car owner is proper, as it does not exceed the charge for repairs authorized by defect card in accordance with first paragraph of rule 94."—*Case No. 1754, St. Louis Southwestern versus North American Car Corporation.*

Straightening Press for Steel Car Parts

An efficient and powerful steam-operated press used in straightening steel car parts at the Danville, Ill., shops of the Chicago & Eastern Illinois, is shown in the illustration. The steam cylinder, with 22-in. piston diameter and 18-in. stroke is rigidly bolted to a heavy iron framework, the piston operating vertically above a face plate 3 ft. 6 in. wide by 8 ft. 6 in. long and located about 14 in. above the shop floor.

The steel framework supporting the cylinder consists



Steam-operated press used in straightening steel car parts at the Danville shops of the C. & E. I.

of 15-in. channels and I-beams riveted together and set on a solid foundation. The spread of the vertical channels is 10 ft. 9 in. on centers and the overall height is 9 ft. About 40 ft. back of this steel framework is a similar steel frame over a heating forge; these two steel frames are tied together and braced against the shop wall by means of 9-in. double channels riveted together to form an I-beam which also serves as a trolley for the 5-ton chain hoists used in handling the heavy steel parts.

The cylinder is shop-made from a scrap locomotive cylinder bushing with top and bottom heads made of locomotive cylinder heads, held together against the bushing by an adequate number of 1-in. tie rods. The piston and piston rod also are of the locomotive type

with the usual packing rings and packing gland. A globe drain valve is provided in the lower end of the cylinder and the usual steam-operating valve is located on the left channel with a throttle lever within easy reach of the operator.

This steam press is used for the most part in the cold straightening of steel car end sills, side sills, center sills, bulb angles, car ends, stakes, braces, posts and doors. When badly bent, some of these parts have to be heated before straightening and in this case the overhead trolley and chain hoist connection to the forge is very convenient. In the case of bent steel car ends, the corrugations are reformed practically like new by the use of rollers and wedge-shaped straightening dies. Special dies are used for stake pockets and similar parts. It is seldom necessary to use more than two men in the operation of this straightening press, which greatly expedites the handling of steel-car work at the Danville shops.

Questions and Answers On the AB Brake

General (Continued)

243—*Q.—How would you proceed to cut out a brake?* A.—Close the branch-pipe and cut-out cock, and drain both reservoirs completely.

244—*Q.—What should be considered when "picking up" a car on the road having AB equipment?* A.—Because of the use of an emergency reservoir in addition to the auxiliary reservoir, approximately twice the time is required to charge the brake system as compared with the K equipment.

245—*Q.—What would be the result if this fact was not taken into consideration?* A.—Unless sufficient time is allowed for charging, the brake may fail to apply during the road test.

246—*Q.—Where can we expect an exhaust of air to the atmosphere following an emergency application?* A.—At the main exhaust port of the emergency portion.

247—*Q.—How long should this blow continue?* A.—For at least 1 minute, and the brake should not be considered defective unless the blow continues longer than 2 minutes.

Cleaning, Lubricating and Testing

248—*Q.—Should the service or emergency portions be cleaned on or at the car?* A.—No. They should be removed from the car and replaced by portions known to be in good condition.

249—*Q.—What should be done with the portions removed?* A.—After first properly protecting them from exposure to dirt and damage, they should be transported to a point provided with an approved test rack.

250—*Q.—What attention should be given the bracket portion?* A.—It should be blown out with compressed air, and the hair strainer should be removed and cleaned. Note: A recommended practice is to carry sufficient strainers in stock to provide for renewals. The dirty strainer should be placed in the protection cover on the service portion, which contains a receptable for this purpose, and forwarded with the service portion to the shop for repairs.

251—*Q.—When dismantling the portions for repairs or cleaning, what care should be exercised to avoid distortion of bolts, studs, nuts, etc.?* A.—Special wrenches should be provided to fit these parts.

252—*Q.—What further care must be taken when dismantling or assembling the parts?* A.—Damage to pistons, springs, gaskets and slide valves must be avoided.

253—*Q.—What is important insofar as choke fittings are concerned?* A.—The size of the various chokes is important and they should be removed, cleaned and gaged.

254—*Q.—What is a good practice in regard to the cleaning of chokes?* A.—It is preferable to remove the chokes one at a time for cleaning and inspection.

255—*Q.—Why should this procedure be followed?* A.—To avoid mixing, that is, to insure that each choke is replaced in its proper location.

256—*Q.—What is the proper method for cleaning chokes?* A.—They should be dipped in a cleaning fluid and blown out with compressed air; no metallic tools should be used to clean the openings.

257—*Q.—When cleaning the portions, what method should be followed?* A.—They should be completely dismantled and all parts inspected and cleaned; also, all parts should be washed in a cleaning fluid to dissolve any oil or grease that may have accumulated.

258—*Q.—How should gaskets or rubber-seated valves be cleaned?* A.—They should be dipped in a cleaning fluid, if the fluid is noninjurious to rubber; the parts must be promptly wiped dry after dipping in the cleaning fluid. Defective gaskets or diaphragms should be replaced with ones in good condition.

259—*Q.—What attention should be given the springs?* A.—They should be inspected for rust pits or other defects.

Jig for Laying Tight Car Floors

To assure laying freight-car floors which will be tight not only when new but after some shrinkage has taken place, the jig shown in the illustration is used at the Northern Pacific freight-car shops, Brainerd, Minn. The device consists simply of an air-cylinder arrangement (one on either side of the car) which permits applying the last few boards at the center of the car with considerably more pressure than would be possible with hand-laying methods and thus squeezing all of the floor boards together at a predetermined pressure adequate to prevent the subsequent development of cracks.

In applying car decking at Brainerd shops with this device, the boards are laid loosely on the car sills or nailing strips, working from each end towards the cen-

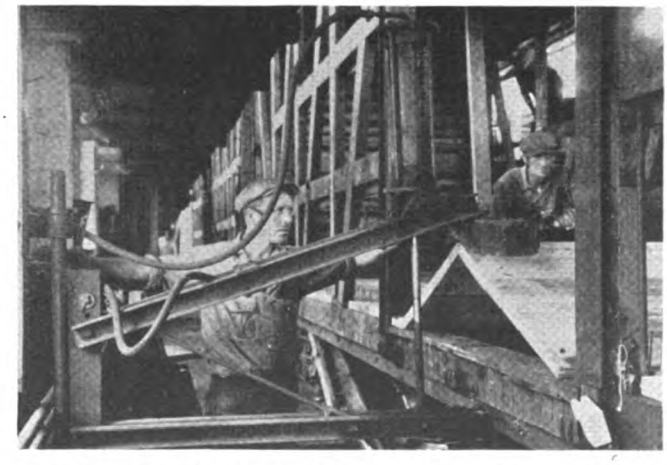


Fig. 1—One of a pair of swing-type pneumatic clamps used in applying freight car decking

ter. These floor boards in each end of the car are then held down against upward movement by 3-in. by 4-in. stringers laid longitudinally on top of the decking and stayed from the car roof. Five floor boards on each side of the car center (and including the additional one or more boards inserted for tightening purposes) are then cleated together and placed in an inverted vee position as shown in Fig. 1. A suitable wooden block is applied at the point of the vee and the air clamp swung into position with the lower jaw under the car side sill and the upper jaw resting on the block.

A similar clamp is applied on the other side of the car and, when the operating valve is opened, air is admitted to both cylinders simultaneously, drawing the two jaws of each clamp together and having the immediate effect of gradually flattening the V-shaped boards and pressing all floor boards in the car together until the vee finally is forced into a horizontal position as shown in Fig. 2, with one extra floor board (or more as required) applied. The decking is nailed lightly at intervals to assure its staying in place; the 3-in. by 4-in. stays are removed; and the final nailing operation is completed, using 3-lb. double hand hammers which not only drive the nails easily in about two blows but have sufficient weight to force the decking down against the car sills.

Referring again to the illustration, the construction of the pneumatic jig will be apparent. The jaws are made of small angles pivoted at the left ends to a vertical steel plate and round bar which is mounted in two substantial eye brackets, rigidly secured to the shop walls. This arrangement permits swinging the jaws parallel with and close to the walls when not in use and thus avoids obstructing the passageway.

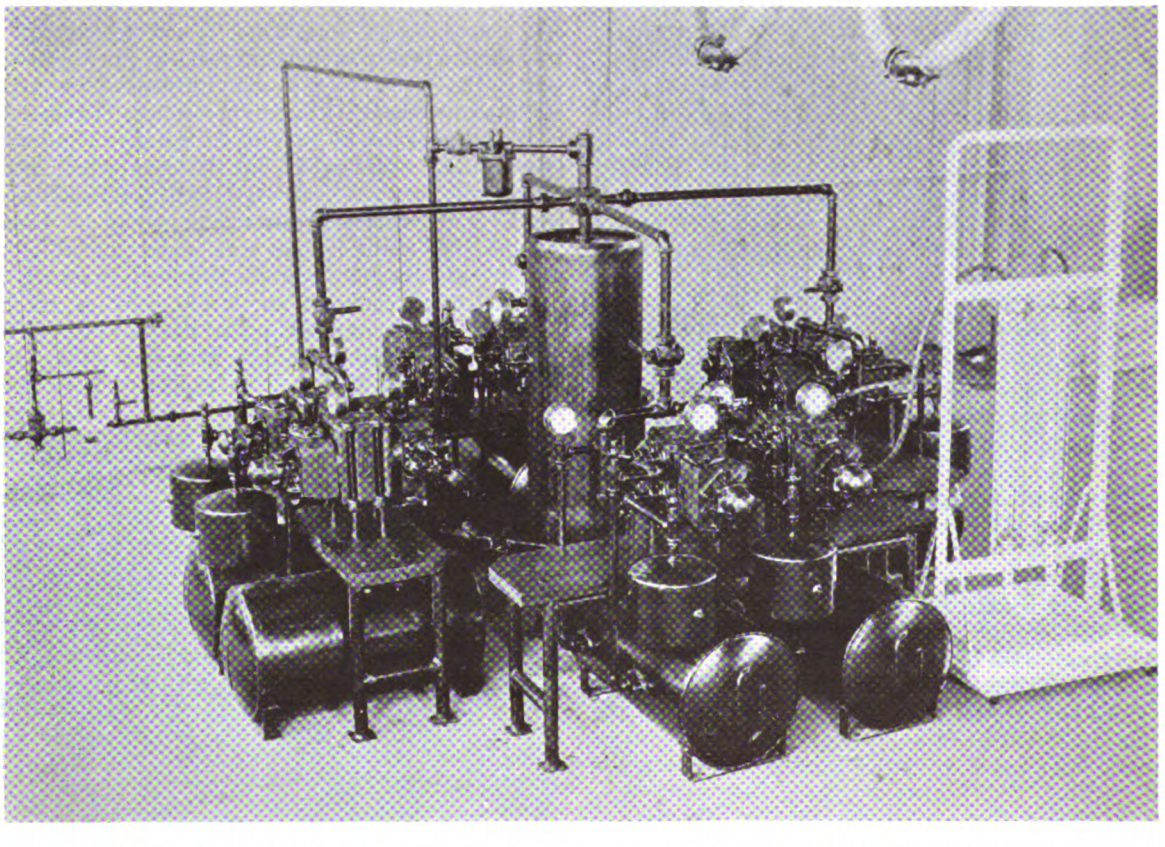
The air cylinder, with a 5-in. bore and 24-in. stroke, is mounted near the end of the upper jaw by means of a pivoted connection and has a piston rod connection to the lower jaw which is also pivoted to permit angular movement. The weight of the air cylinder and outer jaw ends is supported when the jig is not in use by means of a 1-in. diagonal rod with pin connection at the upper left end to the vertical steel supporting plate and a slotted connection to a pin in the lower jaw which adds to the flexibility of the device. In other words, this construction permits the lower jaw to adapt itself to car side sills of slightly varying height.

A similar pneumatic clamp is provided on the other side of the car, both operated by air from a single valve.



Fig. 2—View of the decking after it has been pushed down, with all boards tightly in place

* * *



Automatically operated eight-car AB brake endurance test rack of the New York Air Brake Company

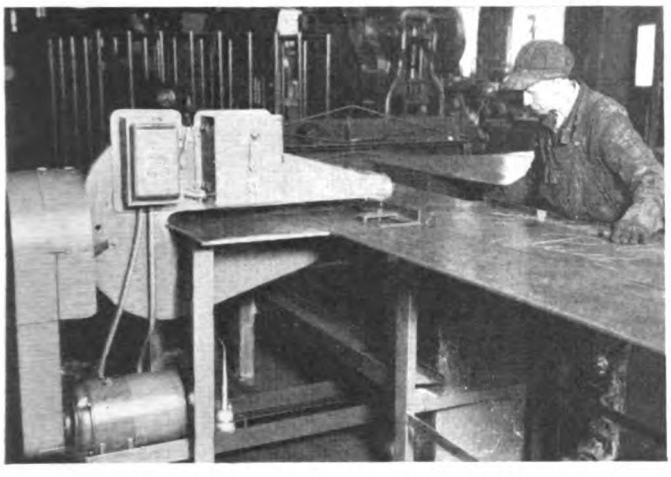
At the right is a U2 Mercury manometer which registers application and release differentials of the AB valve. In the center is the control mechanism for automatically charging and reducing the brake pipe in one-minute cycles. In front of the valves are 10-in. by 12-in. diameter cylinders. Otherwise the brake equipment is the same as used on freight cars.

IN THE BACK SHOP AND ENGINEHOUSE

Motor-Driven Sheet Metal Shears

An unusually efficient and convenient type of motor-driven sheet metal shears, which was made and is now being used at the Danville, Ill., shops of the Chicago & Eastern Illinois, is shown in the illustration.

The frame of this machine is constructed of angles



Shop-made sheet metal shears used at the Danville shops of the C. & E. I.

welded together and designed to support rigidly the shearing unit and a large table made of ⅜-in. sheet steel. The U-frame which carries the cutter shafts is a welded, built-up structure made of heavy tank steel. The two cutter shafts, mounted one in the upper and the other in the lower jaw of the machine are equipped with roll cutters at the outer end which, when brought together serve to shear sheet metal sheets quickly and easily to any shape or design required. The cutter shafts are gear-driven from a 1½-hp. electric motor mounted in the base of the machine.

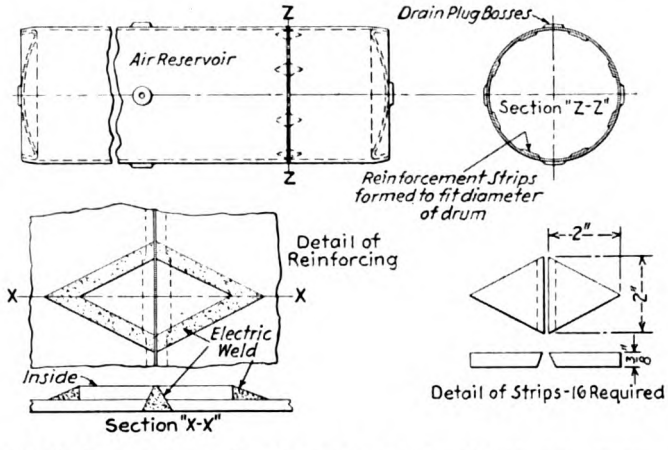
The work done on this machine is primarily locomotive jacket work. However, other light sheet metal parts, such as stove pipes, galvanized spouting, and galvanized material for various utensils, are cut on this machine. The machine is used to make both straight cuts and circles with a comparatively small radius.

Prior to the adoption of this machine, all jacket and light sheet metal parts were cut with a large pair of hand shears. This machine has eliminated the use of the large hand shears, and results in a saving of approximately 20 per cent in labor cost in preparing and cutting a locomotive jacket.

Changing the Size Of Air Reservoirs

Locomotive main air reservoirs sometimes have to be lengthened to provide increased capacity or possibly shortened to fit in a restricted space. In either case, the method illustrated may be used to good advantage, as it involves the welding together of two reservoir sections of any desired length by means of a reinforced circumferential seam which gives equivalent or even more strength than in the original reservoir.

Referring to the drawing, the general method of preparing and welding this circumferential air reservoir seam is shown. The edge of each section of the reservoir is beveled to an angle of about 30 deg., and diamond-shaped reinforcement strips are cut in two, beveled and electrically welded to the inside of the reservoir, being spaced as shown and applied before the reservoir sections are placed in position for welding. The reinforcement strips are made of ⅜-in. boiler steel of the shape indicated and formed to fit the inside diameter of the reservoir. Sixteen reinforcement strip pieces in all are required and they are spaced on each side of the



Details for preparing and welding the circumferential air reservoir seam

drain plug bosses as shown, to permit the reservoirs to drain properly.

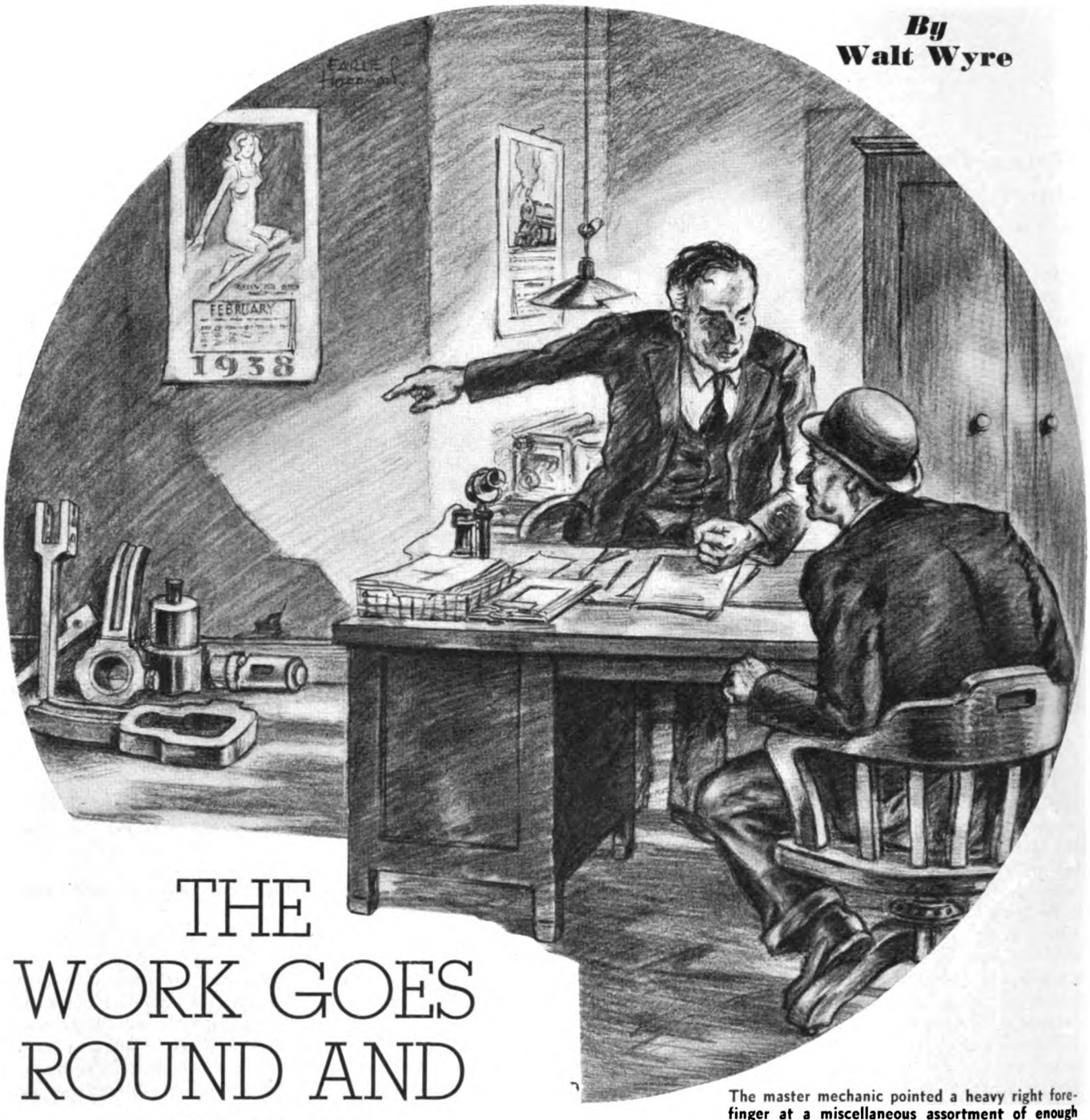
After the air reservoir sections are lined up accurately in position they are tack welded on opposite sides to prevent them from being drawn out of line. The reinforcement strip pieces are welded together and the seam finished smooth and flush with the outside of the reservoir. This method of lengthening and shortening air reservoirs may, of course, be used with equal success on all types of cylindrical reservoirs and drums.

Power Chucking Wrench

The Cushman Chuck Co., Hartford, Conn., recently developed a uniform-torque power wrench for production chucking of pieces in lathes, drill presses and milling machines which is designed to lessen the fatigue on the operator and to produce a uniform chucking pressure for eliminating distortions usually due to unequal pressures on chuck jaws when tightened by hand. The power wrench includes a high-torque constant-speed reversible motor, a reduction gear and a splined drive shaft. One end of the drive shaft engages the chuck-

(Continued on page 77)

By
Walt Wyre



The master mechanic pointed a heavy right forefinger at a miscellaneous assortment of enough scrap steel in one corner of the office to start a fair size junk yard

THE WORK GOES ROUND AND ROUND

"EVERY one of the failures could have been prevented!" H. H. Carter, master mechanic on the Plains Division of the S. P. & W., pounded the desk to emphasize his statement. "Not only could they have been prevented, they should have been!"

Jim Evans, the roundhouse foreman, squirmed uncomfortably. "But Mr. Carter—"

"No buts about it," Carter interrupted. "They should have been prevented—old breaks, every one of them!" The master mechanic pointed a heavy right forefinger at a miscellaneous assortment of enough scrap in one corner of the office to start a fair size junk yard.

In the pile of parts were pieces of combination levers, the end of a main rod, a broken eccentric rod, and various other parts of locomotives. Each piece represented an engine failure. Each part under the constant hammering and pounding of a heavy working locomotive had given way. As the master mechanic had said, the broken sections all indicated that the breaks had started from old cracks. In most cases, the break had progressed from a crack at a corner of the piece. The master mechanic leaned over and pointed at the broken end of an eccentric rod.

"Look at that—nearly a third old break! The inspectors should have found that."

"It's sometimes pretty hard to see a crack," Evans

said defensively. "Sometimes they're on the back side."

"They've got mirrors," Carter cut in. "We've given them mirrors, flashlights, and magnifying glasses, and they're supposed to have good eyes, but that's not the point. The point is I want such failures to stop. They've got to stop!" Carter pounded the desk again.

"We'll do our best," the foreman replied.

"I don't care what you do or how you do it, but I don't want any more failures from broken rods." The master mechanic picked up a letter. Evans took the hint and left.

When Evans reached the roundhouse he located the laborer that wipes the rods. "I want all of the rods cleaned and whitewashed every trip," the foreman told the laborer. "After they're whitewashed and inspected, clean them off. I'll give you another man to help you."

The campaign to reduce failures from broken rods was on. The roundhouse smelled like a pre-prohibition cooking plant, the odor of alcohol was so strong.

The whitewash was a mixture of powdered whiting and alcohol. It dries quicker than when mixed with water, and Evans claims makes a finer grained whitewash that shows up cracks better.

Every rod that showed symptoms of the tiniest hairline crack was taken to the blacksmith shop and treated. Hardly a locomotive was turned without some part being thus treated.

Some were cracked, others had, as the blacksmith expressed it, "equators" because the lines were imaginary.

Every one in the roundhouse became crack conscious from cellar packer to cab man. Even the jacket wipers took a look along the side of every engine they passed looking for cracked rods.

The intensive effort brought results. The epidemic of broken rods was stopped, for the time, at least. There was another and less pleasing result. Every one was so busy looking for cracks, little time was left for other work.

Machinists were busy removing and replacing suspected or guilty parts. Laborers were busy whitewashing and cleaning. The blacksmith fire usually had a crack suspect heating in it. Inspectors only needed a Sherlock Holmes hat and calabash pipe to be taken for detectives looking for clues.

One morning Evans was making out his engine lineup when the messenger brought in a wire. "Pink one for you, Mr. Evans," the messenger said.

Messages on ordinary yellow paper are bad enough, but ones on pink usually mean trouble. This one was no exception: "Engine 5086 held at Sanford by federal inspector account worn driving boxes and rod bushings." The message was signed with the initials of the master mechanic.

The foreman dropped the pink slip on the desk like it had burned his fingers. He finished the lineup hurriedly and headed for the roundhouse.

The 5079 was on the drop-pit and had been for over three weeks. Since the campaign against cracked rods started, machinists had little time for dead work. Even the ones assigned to the drop-pit were pressed into service occasionally to help out on running repair.

Evans found machinists Jenkins and Cox, assigned drop-pit men. Both nut-splitters were working on running repairs.

"Let's get on the 5079 and get it out right away," the foreman told them. "Soon as we get her out, two or three other engines have got to go over the pit."

The master mechanic returned to Plainville next day. He called the foreman to the office and lectured long and loud. "There's no excuse for allowing locomotives to be run with driving boxes and rod bushings worn past the limit," the master mechanic began and ended his lecture.

Evans assured him that it would not be allowed to happen again.

And the campaign against worn bushings and brasses was on. An additional machinist and helper were assigned temporarily at the drop-pit. A machinist put in eight hours a day turning driving box brasses. The crank pin grinder that had been idle for many weeks began making the sparks fly truing up tapered and out of round pins. Driver journals were rushed to the wheel lathe to be turned.

The sudden increase in consumption of brass was so great that the storekeeper suggested that a brass foundry should be added to the S. P. & W. facilities at Plainville.

Extra work incurred putting boxes and bushings in condition took a lot of time that had previously been used in the crack clean-up campaign. Inspectors met incoming engines on the lead and carefully checked driving box pound while the hoghead or hostler pumped them. Magnifying glasses were not used as assiduously. Long lining bars became bright from constant use by inspectors using them to test wear in rod bushings by lifting the rods.

Rome wasn't built in a day, neither can a locomotive in a roundhouse be run over the drop-pit, have the drivers dropped, crown brasses renewed, journals and pins trued, and other work incidental to such procedure be accomplished in eight working hours. Everything considered though, exceptionally rapid results were obtained in the work at Plainville.

With so much of the work being done, many time-saving methods were evolved. Some short cuts were suggested by the foreman, but a larger number were ideas of the mechanics doing the work.

A minor but irritating outcome of the wholesale renewal of bushings and brasses was a sudden increase in the number of hot pins and boxes. When possible, locomotives just off the drop-pit were broken in by being run on a local. A couple of them were used one day each in the yards switching but the hogheads on the goat yelled their heads off about using road engines for switching.

Sometimes conditions didn't allow time for properly breaking in the new bearings. In such cases they were limbered up a little by running them up and down the lead. Liberal doses of oil and crater compound were given the pins and journals. Extra cakes of grease and sticks of pin dope were given the engineer along with the fervent hopes of the foreman that the engine wouldn't run hot.

Except for the minor annoyance of occasional hot pins and journals, everything was going good at Plainville until the cylinder fell off the 5091.

Was that a mess! The engine right off the drop-pit had made one trip on the local, made a good trip, too, only the right main pin ran a little hot. The hogger didn't have to put water on a single journal.

The next trip was on 71, the fast Gold Ball freight. Forty miles out of Plainville the cylinder dropped off. Traffic was tied up four hours getting the engine and train off the main line. The superintendent, trainmaster, and master mechanic prized up more hell than old Nick ever heard of and that was only the beginning. The superintendent of motive power and general manager took out a few chunks by wire, then went to Plainville for a personal appearance.

"Didn't you know the cylinder casting was cracked?" the master mechanic asked Evans.

"Sure," Evans replied. "I knew it was cracked but I didn't think it was bad enough to do any damage. Half of the engines running out of here have cracks in cylinder castings that look as bad as that one did. I thought—"

"If you had thought," the master mechanic cut in, "you would have tied the engine up until the casting was repaired."

The official didn't intend to be personal, he was only passing on to the foreman a little of what he had received a lot of from the officials over him.

"Well," Evans shoved his chew of "horseshoe" into his cheek with his tongue, "maybe we had better go over all of the cylinder castings and get the ones that might cause trouble welded."

"Of course we should," Carter said before he realized that he was assuming responsibility with the foreman. Then he added, "All right, I'll go over them with you and we'll decide which ones should be repaired."

Every engine that came in was carefully inspected for cracked cylinder castings. Inspectors marked cracks they found with yellow keel. The foreman and master mechanic then examined them and decided what was to be done.

Some were chipped out and welded with bronze. Some were re-enforced with studs before being welded. Ones that didn't look too bad were pronounced O.K. for service but with the understanding that they would be carefully watched. One engine, the 5077 was sent to the back-shop to have the cylinder castings renewed.

Things went along fairly quiet at the Plainville roundhouse for some time. Evans was beginning to feel that his wasn't such a bad job after all until one morning the federal inspector dropped in unannounced as federal inspectors have an annoying habit of doing.

Evans had just picked up a piece of yellow clip and read the short but sweet typed line "engine failures—blank" when the federal inspector came in. The foreman took a deep breath and managed an outwardly cheerful "good morning."

The inspector returned the greeting with a hand-shake, then stepped into the foreman's private office and put on a suit of unionalls.

The 5092 was standing on the lead called for the Limited. The engine crew was already on her.

"Sit down," Evans invited cordially when the inspector came back into the main office. "Have a smoke."

The inspector took the cigar but didn't sit down. "Thanks," he replied, "I'll smoke this after while; guess I'd better work a little now."

The inspector edged towards the door, the foreman reluctantly followed. "What's that going on?" the inspector indicated the 5092.

"The Limited," Evans replied.

"Let's look at her," the inspector said in a matter-of-fact tone.

Evans had little apprehension as they walked towards the locomotive. Of course the engine wasn't perfect, but she was in pretty good shape.

The federal inspector walked around the engine in what appeared a very casual manner. "Looks like that main driver tire flange is a little sharp," the inspector commented in an equally casual manner.

"I'll get a gauge." Evans turned towards the office.

"Never mind," the inspector said, "I've got one."

The tire didn't take the gauge, but what it lacked was so little that Evans held his breath while it was being tried. One more trip would be enough to finish it.

"I'm going to turn the tires when she gets back," the foreman said.

"Good idea," the inspector commented.

The 5092 was not the only engine that had badly worn tires. Others were equally bad and the 5083 that Evans was figuring on running west that night was so bad that the foreman marked up another engine.

He hadn't realized that tires on so many engines were getting in bad shape, meaning both condition and contour. It didn't seem like any time since most of the engines had been over the drop-pit. At that time all that were too bad had been renewed or turned, and most of them needed attention again.

The federal inspector didn't tie up any engines. He reported a few defects, most of which could be remedied without a lot of trouble. Before leaving, however, he did again casually mention the condition of driver tires, very casually, but Evans took the hint.

Once more the drop-pit was a busy machine and the wheel lathe running steadily eight hours a day. The smell of burning paint hung heavily on the roundhouse and the clang of striking sledges hammering hot tires a familiar sound as tires too thin to turn were replaced.

As the crusade against broken rods had given way to the brass brigade, the cracked cylinder campaign gave way to the war on tread worn tires.

If the job of running a roundhouse were merely a matter of correcting certain conditions and they would stay corrected, a foreman's job would be the sinecure some folks think it is. If to paraphrase what Bill Shakespeare said long ago, if it were done when it is done, the sooner the better, or something like that.

But railroading is not like that. A roundhouse job is more like that of the guy that landed the job of killing the Hydra, a fierce serpent with a lot of heads some say seven, but more recent accounts make it nine heads the serpent had. Anyway, every time one head was cut off, two more showed up in place of the one cut off. Hercules—the guy's name was—would have made a good roundhouse foreman because that Hydra didn't have a thing on a roundhouse. Get one job done and you think it's done for good, up pops two more waiting to be handled. It's just like the Hydra another way, too. The job that's biting at you the hardest at the moment is the one that must be chopped off.

Whitewashing rods every trip had long since been not exactly forgotten but rather neglected for lack of time when the federal inspector suggested that some of the tires needed attention. Efforts were made to continue eternal vigilance against broken rods, but with other jobs needing attention worse, Evans just kinda let it slide.

Rods had been whitewashed at the end of every round-trip at first. Then locomotives needed badly were allowed to make a trip without it. Get them next trip, they figured. Sometimes they did, sometimes they didn't, until slowly but surely they got back to the old practice of whitewashing only on monthly tests.

THEN wham!—the 5088 broke a main rod—broke off right up close to the back end—tore up a lot of the valve motion, knocked a head out of the cylinder and broke the guide yoke. Besides doing a lot of damage that cost a lot of money to repair, the crack passenger train was held nearly three hours waiting for an engine.

Two days later the 5091 snapped an eccentric rod. It didn't do as much damage, but was a nasty failure.

Again the master mechanic called the foreman to the office. "Those failures could have been prevented!" the master mechanic said emphatically. "Look at 'em! Old breaks! There's no excuse for such failures."

"But—" Evans started to reply, but Carter cut him short.

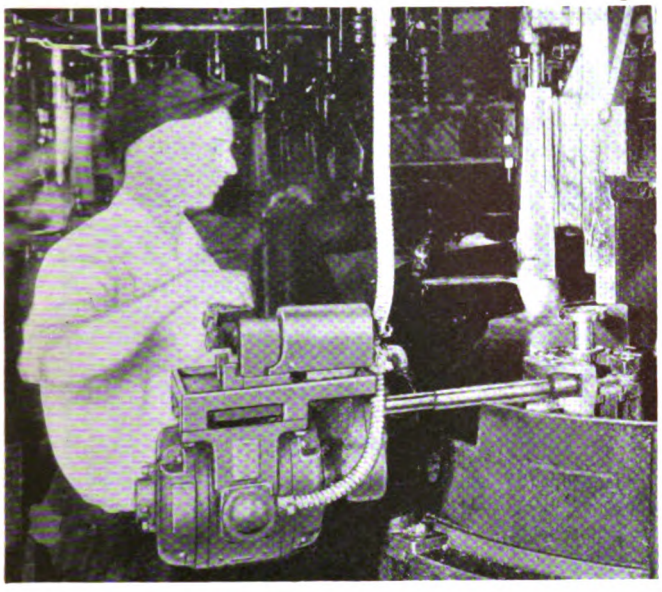
"No buts about it! Such failures have got to stop!"

"Yes, sir," Evans agreed, and the campaign was on against cracked rods, and so on ad infinitum.

Power Chucking Wrench

(*Continued from page 73*)

ing wrench through a suitably formed socket. The other end of the shaft is splined to permit horizontal adjustment of the shaft for various diameters and positions of work. The control button for the motor is mounted in the splined end of the shaft. The entire unit is mounted on the bed of the machine by a bracket



An application of the Cushman power chucking wrench

on which the wrench can swivel, so that if the operator should leave the wrench in the chuck no harm will result when the machine indexes.

The propelling power of the standard wrench manufactured by this company is based on utilizing a motor with a torque of 24 ft.-lb., which is estimated to deliver a driving torque of approximately 300 ft.-lb. at the end of the splined shaft. However, units which produce 8 ft.-lb. and 16 ft.-lb. motor torque for lighter work can be built to specifications. The torque thus provided by the chucking wrenches makes it possible to attain uniform gripping pressures of the chuck jaws, an obvious advantage in production work, especially where machined parts are finished to micrometer sizes.

Valve- and Cylinder-Bushing Applicator

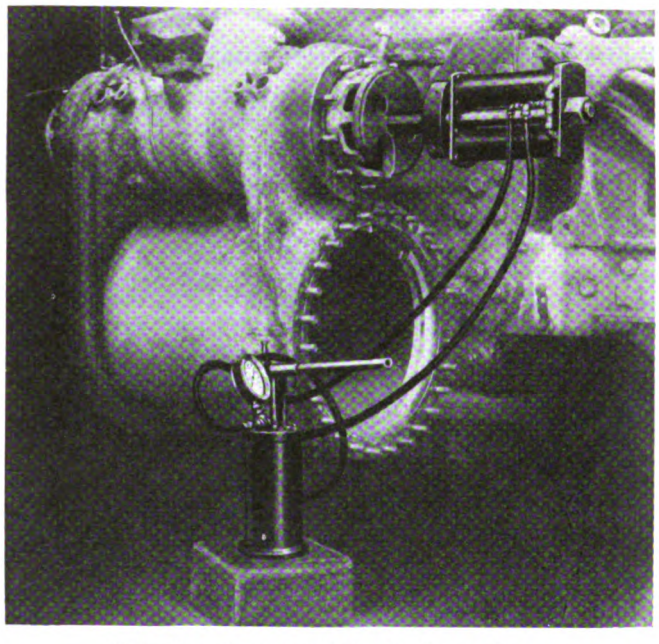
The cylinder-bushing applicator illustrated, which is a light, compact and efficient unit, has recently been developed by the Portable Hydraulic Equipment Company, Chicago, Ill., for use in applying locomotive valve and cylinder bushings by hydraulic pressure. The complete unit, which can be easily handled, set up and operated by one man, consists of an oil-operated, four-speed hydraulic hand pump, and bushing applicator press of 35 tons capacity.

The Rodgers hand pump is built into a housing which serves as a reservoir for five quarts of oil and supports the pump head. The cylinder and valve are made in a single unit of bronze, being attached to the housing base and equipped with ball-type suction and discharge valves. The piston is a ground fit in the cylinder and no leather or other packing is used. The shift block on the pump head is combined as a unit with the operating handle. A simple patented device is said to provide instant control of leverage speed changes.

Under normal operating conditions one man can produce 4,000 lb. pressure on high speed (short leverage) or 10,000 lb. on low speed (long leverage). At 30 strokes per minute on high speed, a 2½-in. stroke of the pump piston produces a volume of approximately 60 cu. in. of oil. At low speed, a ½-in. stroke produces a volume of 12 cu. in. of oil. The pressure hose is metal lined, and tested at 22,000 lb. per sq. in. The return hose is oil proof. The pump is equipped with a gage indicating pressures in pounds and tons.

The double-cylinder press is a simple arrangement of two cylinders fitted with suitable pistons, cover plate and crosshead. The outer ends of the cylinders are welded to a single base plate. The crosshead, cover and base plate have a $2\frac{1}{16}$-in. hole in the center of each, with a cylinder on each side, this construction allowing the press to slide on the center bar in such a way that the press may be anchored by a base nut in any desired position on the center bar. The ram travel is 12 in., and the combined capacity of the two cylinders 35 tons.

This bushing applicator applies valve bushings simultaneously and is equally effective in applying cylinder bushings. The device eliminates the need for power



Hydraulic valve and cylinder bushing applicator

equipment, such as electric or compressed-air motors and the use of cranes for handling heavy parts. The operator can read and control the pressure accurately during the operation.

Fan-Cooled Motors on Hammond Grinders

Hammond Machinery Builders, Inc., Kalamazoo, Mich., has equipped all of its grinders of 3 hp. and over with totally enclosed fan-cooled motors. The rotor and stator on these units are in an enclosed chamber sealed against the entrance of foreign matter. Two fans force cooling air around the outside of this chamber, serving to ex-

tract heat from the motor. The fan-cooled type motor is said to withstand greater overload with a lower temperature rise. The company's grinders are equipped with automatic starters with thermal overload protection, oversize ball bearings, adjustable eye shields made of shatterless glass and pushbutton remote control.

Hammond heavy-duty grinders especially adapted to service in railway shops, are available as equipped with totally enclosed fan-cooled motors in sizes of 5, 7½ and 10 hp. type WH.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Boiler Cracks at Waist-Sheet Angles

Q.—What causes the shell of a locomotive boiler to crack at the waist-sheet angles? Can it be remedied?—M. E. D.

A.—The practice of securing waist-sheet angles to the boiler shell with studs of rivets affects the normal and equal expansion and contraction of the shell. When applying riveted angles to the shell, such as the waist-sheet angles, the shell plate becomes more rigid at the point of application than the surrounding area and, due to the expansion and contraction of the boiler sheet, stresses are set up in the plate around the waist-sheet angle caused by the rigidity of the construction at this point. These angles, to which the waist sheets and the guide-yoke sheets are attached, transmit stresses and strains set up in the frames, by the running gear, to the boiler shell directly.

Boiler steel has a high tensile strength and such material is less homogeneous and pliable than material of lower tensile strength; for this reason, it is unable to absorb the stresses transmitted through the waist sheets. The shell course generally cracks and falls at or near the ends of the angles due to the tensional stress at these points which is caused by unequal expansion and contraction. The best remedy is to cut the waist sheets loose from the boiler and apply a liner riveted to the outside of the shell between the shell and the waist-sheet angle, thus preventing the waist-sheet angle from wearing into the shell plate.

Bulges in Front Tube Sheets

Q.—What causes the front tube sheet to bulge? Should the front tube sheet be straightened at each shopping?—M. L.

A.—The bulging of the front tube sheets of a locomotive boiler can be attributed to several causes. The most common are:

(1) An improper fit of the tube sheet in the shell of the boiler, whether it is too large or to small, will cause considerable bulging immediately after the boiler is put into operation. When the sheet is too tight it will bulge in and when it is loose it will bulge out.

(2) The rolling of the flues in the tube sheet is the most common cause of the tube-sheet bulging. When using hand rollers, each tube hole is expanded 0.007 in. With a self-feeding roller and an air motor the holes are stretched 0.021 in. The rolling operation, considering the number of tube holes in a tube sheet, results in a considerable outward stretch in the sheet toward the shell of the boiler, where the outer rim of the tube sheet being solid refuses to permit any more movement in that direction, thus causing the tube sheet to bulge.

(3) The expansion and contraction of the boiler tubes puts considerable strain on the tube sheets, and although this condition is generally taken care of by the use of copper ferrules in the rear tube sheet, the practice of seal welding the tubes often defeats the purpose of the ferrules, causing the tube sheets themselves to take the load due to expansion and contraction. Obviously, the tube sheets will bulge under these conditions.

Some shops straighten the tube sheet with a bar bolted across the flue sheet, pulling the sheet up to the bar. However, the general practice is not to straighten out the bulge at each shopping, most of the front tube sheets lasting the life of the boiler.

Mean Effective Pressure Defined

Q.—What is meant by the term "mean effective pressure" and what relation does it have to the boiler pressure of the locomotive?—B. B.

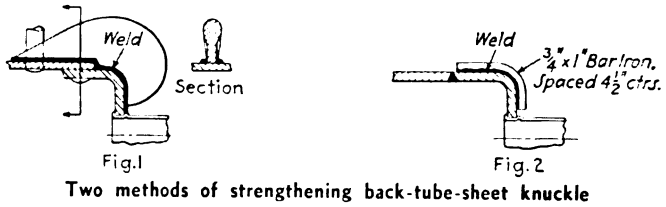
A.—The term "mean effective pressure" relates to the pressure in the cylinders and is the average useful pressure which does work in the cylinder; it is the average pressure exerted on the piston, throughout its stroke, and is calculated from the average of ten ordinates on the indicator card or by means of the planimeter.

It has no direct relation to the boiler pressure except that the boiler pressure, minus whatever loss occurs between the boiler and the cylinders, is the initial pressure upon which mean effective pressure is based.

Cause of Cracks in Tube-Sheet Knuckles

Q.—What causes cracks in the knuckles of the back tube sheets and what can be done to prevent these cracks?—D. E. D.

A.—Cracks in the knuckle of the back tube sheet are caused by the working of the tube sheet, due to the unequal expansion of the boiler shell, the boiler tubes and the firebox. Various methods are used for strengthening the knuckle of the back tube sheet to prevent such cracks. The two most common are shown in Figs. 1 and 2. Fig. 1 illustrates a specially designed reinforcing rib welded in place as shown on a 4 to 6 in. pitch. Fig. 2 illustrates a bar-iron reinforcing strap welded in place as shown. The purpose of the reinforcing ribs is to stiffen the knuckle so that the sheet, rather than the knuckle will take up the expansion.



Two methods of strengthening back-tube-sheet knuckle

(Turn to next left-hand page)

Another bulletin of importance to railroad men—

80 Million Car Miles Per Wheel Failure* *Are Not Enough!*

Mileage between failures of chilled car wheels has shown a remarkable increase since the adoption of the single plate wheel. Today it is three times what it was in 1927, and the age of failed wheels has increased 80% to an average of 9.2 years. But this is not enough.

Chilled Car Wheel Inspection Service Promises Better Performance

One of the major purposes of the rigid inspection system now operating in our Member plants is the further improvement of this record. To attain that end, we now maintain resident inspectors who follow every step of manufacture on every heat.

Our own release is necessary before chilled car wheels can even be offered for test and acceptance by the Railroads.

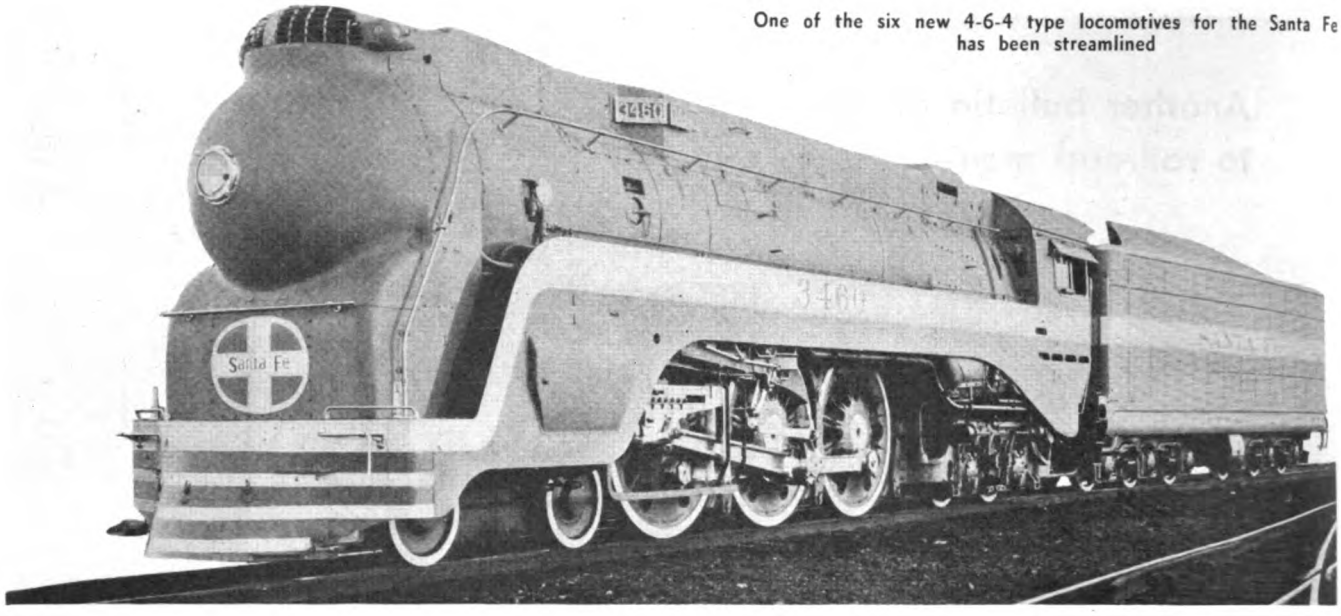
Already, the results show a far greater uniformity of output—a most encouraging beginning of this new feature of our Association work.

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*Based on the performance of over 15,000,000 chilled car wheels in service.

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One of the six new 4-6-4 type locomotives for the Santa Fe has been streamlined

NEWS

Improvement Programs

The Missouri Pacific has prepared plans for improvements to 9 of the 12 engine stalls in its enginehouse at 14th and Pinkney streets, Omaha, Neb. Each stall will be extended 20 ft. Three mechanical draft units and new heating equipment will be installed at a cost of about $45,000.

The Lehigh Valley has asked the Interstate Commerce Commission for permission to borrow $778,000 from the Reconstruction Finance Corporation for repairs and to buy new rolling stock. The company needs to repair 1,460 steel coal cars and would reemploy 300 men to carry out this work at its Sayre, Pa., and Packerton shops.

The New York, New Haven & Hartford has petitioned the court for permission to purchase 50 lightweight streamline passenger coaches, estimated to cost $2,100,000. This will bring the total of this type of equipment on the New Haven to 200 cars. The court was also petitioned to permit the purchase of 10 Diesel-electric switching locomotives to cost $750,000.

Santa Fe Receives Six New Locomotives

THE Santa Fe has received from the Baldwin Locomotive Works six high-speed 4-6-4 type oil-burning locomotives, one of which is streamlined, for use in passenger service between Chicago and La Junta, Colo., a distance of 992 miles.

The streamlining of engine 3460, which has a steam pressure of 300 lb. per sq. in., is designed to blend into the contour of the train. The shrouding is painted in two shades of blue, while the underportions of the locomotive and tender, including the running gear, are painted black. An 18-in. stainless-steel strip, on which the words "Santa Fe" and the number "3460" are painted, extends from the front of the locomotive to the rear of the tender on each side at the level of the running board. Other striping is in silver leaf and the faces of the driving wheel tires and hubs are painted aluminum, as are also the tires of all the engine- and tender-truck wheels. Although at present equipped for burning oil, the engine and tender are so designed that coal-burning equipment, including a mechanical stoker, can subsequently be applied if desired.

One of the six new engines in a test run recently hauled the Santa Fe's fast mail train, No. 8, from Los Angeles to Chicago, a distance of 2,227 miles, without a change.

Railroads Ask I. C. C. to Modify Power Gear Order

IN the hope of lightening their financial burden during the coming year, the Association of American Railroads has petitioned the Interstate Commerce Commission to modify its order of June 8, 1937, relative to the installation of power reverse gears. The commission's order provided that the railroads should install power reverse gears on all locomotives when they were brought in for class 3 or heavier repairs. The railroads would have the commission modify this order so that they will be required to install the gears when class 1 or 2 repairs are made. The petition calls attention to the fact that prior to the entry of the commission's order, the complaining brotherhood officials and the railroads entered into an agreement providing for the installation of power reverse gears on all locomotives when they were shopped for class 1 or 2 repairs, with all installations to be made not later than January 1, 1942, unless otherwise agreed between the management and the general committees of the brotherhood.

The railroads particularly called attention to the serious financial condition which they are in at this time and pointed out that the installation of power reverse gears will be unnecessarily hastened if the commission's order is followed because of the greater frequency of class 3 repairs. They go on to contend that all locomotives will have to be equipped by 1942 with the result that there is no need at this time to speed up the installations.

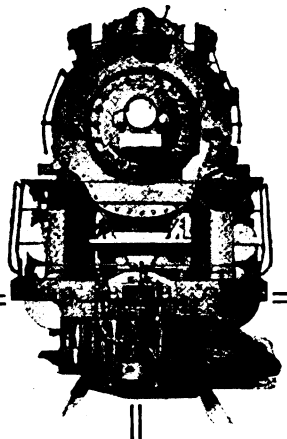
156 Fusion-Welded Tank Car

THE Interstate Commerce Commission has recently granted applications of five companies for authority to construct a total of 156 fusion-welded tank cars. The largest number of cars was involved in the application of the Union Tank Car Company for authority to build 100 for the transportation of petroleum products. The General American Transportation Corporation was authorized to build 25 and the American Car and Foundry Company 14 for the transportation of anhydrous ammonia, while the former will build another five, nickel-clad, for carrying caustic soda solution. The remaining 12 will be built of chromium steel by E. I. duPont de Nemours & Company for the transportation of nitric acid.

New Research Heads for A. A. R.

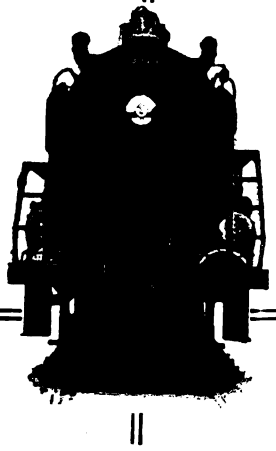
J. J. PELLEY, President of the Association of American Railroads, has announced the appointment of William I. Cantley as mechanical engineer, Mechanical Division, and G. M. Magee as civil engineer, Engineering Division. Both men will be in charge of research so far as their respective divisions are concerned, according to

(*Continued on next left-hand page*)



Locomotive Designs are CHANGING

Locomotives recently purchased and those being considered today provide higher horsepower capacity and higher speeds in line with present day operating conditions. » » » Lima's engineers will gladly consult with you and recommend designs that provide this higher capacity to meet modern requirements.



LIMA LOCOMOTIVE WORKS INCORPORATED, LIMA, OHIO

the announcement. This work was formerly under the direction of L. W. Wallace who, on December 1, resigned as Director of the Division of Engineering Research.

Mr. Cantley has had wide engineering experience, having been for the past 20 years mechanical engineer of the Lehigh



W. I. Cantley

Valley. He was born in Philadelphia on July 19, 1883, and was educated in private school and at Drexel Institute. From 1902 to 1915 he was connected with the Engineering Department of the Baldwin Locomotive Works and on November 1, 1915, was appointed assistant mechanical engineer of the Lehigh Valley, being advanced to Mechanical Engineer on March 15, 1918. Since 1927 he has been Chairman of the Committee on Locomotive Construction of the Mechanical Division of the A. A. R.

Mr. Magee since last August had been assistant director of the Division of Engineering Research, A. A. R. Prior to his connection with the Association he was assistant engineer of the Kansas City Southern, where he had wide experience in civil engineering.

I. C. C. Issues Stoker Order

FOLLOWING the recommendations of Special Examiner Homer C. King's proposed report which was abstracted in the October, 1937, issue of the *Railway Mechanical Engineer*, the Interstate Commerce Commission, on December 30, issued an order requiring the railroads of the country to equip approximately 3,500 of their locomotives, used in through service, with automatic stokers. The 30-page report, which was written by Commissioner McManamy who handled the case, gives his reasons for requiring the railroads to install automatic stokers which may be summarized as follows: Bad effects of firebox glare on the eyesight of the fireman, danger from firebox explosions or back fires, poor health caused from exposure of fireman to extremes of temperature, fatigue induced by hand firing, inability of firemen to keep a proper lookout in accordance with operating rules with the resultant danger to employees and passengers of collisions with both trains and automobiles.

The order of the commission states that the use in fast or heavy passenger service of hand-fired coal burning locomotives which weigh on driving wheels 160,000 lb. or more, and the use in fast or heavy freight service, of hand-fired coal-burning locomotives which weigh on driving wheels 175,000 lb. or more, causes unnecessary peril to life or limb, and the safety of employees and travelers on railroads requires that all such locomotives be equipped with a suitable type of mechanical stoker. The order further states that all coal burning locomotives of the stated weights built on or after July 1, 1938, shall be equipped with a suitable type of mechanical stoker and such stokers shall be properly maintained.

The commission will also require all hand-fired coal-burning locomotives of the stated weights used in fast or heavy service, built prior to July 1, 1938, to have a suitable type of mechanical stoker. The order goes on to state that each railroad which operates hand-fired coal-burning locomotives of the stated weights shall file with the Chief Inspector of the Bureau of Locomotive Inspection as of July 1, 1938, a list of all hand-fired coal-burning locomotives of the stated weights built prior to July 1, 1938, which will in the future be used in fast or heavy service on its line, and that mechanical stokers will be applied each 12 months period to not less than 20 per cent of the total number so listed, and that all locomotives of the stated weights which are in those services on each railroad shall be so equipped before July 1, 1943, and that such stokers shall be properly maintained. The commission concludes its order by saying that "for the present our order shall not apply to deckless locomotives equipped with two cabs which are generally known as the 'Mother Hubbard type' built prior to July 1, 1938."

Bearing in mind the fact that it is "extremely difficult if not impossible to meet every operating condition or safety need from a single record," Commissioner McManamy assures the railroads that "if experience shows that the standards here presented are inadequate, or are unnecessarily burdensome, they may be brought to our attention for modification or amplification as the results of the experience may require." He also amplified his decision by saying that the order did not prohibit the use of hand-fired coal-burning locomotives where two firemen are used.

Recognizing that some of the carriers are in a precarious financial condition, Commissioner McManamy states that "Our order has been so drawn and limited as to minimize the expenditures in so far as it can be done without disregarding the safety of employees and travelers." He further asserts that "it is apparent that the cost will be very much less than the amount estimated by the defendants and the benefits to be derived will be substantial." The railroads, in answer to the complaint, had estimated the cost of installation at $115,000,000.

Commissioner Lee, concurring in part, agreed that stokers should be installed on freight and passenger engines in fast and heavy service, but objected to forcing the carriers to install them on locomotives used in local, yard, and branch line service. "As it applies to the latter service," he said, "I do not believe the order can be justified on the ground of safety. Under their present financial condition, the carriers should not be required to make unnecessary expenditures."

Commissioner Eastman dissented from the majority, saying that "The order entered herein will not be a serious burden upon the railroads, because of the long time allowed for compliance and the likelihood that there will be compensation for much of the cost through the efficiency gained by the use of the automatic stokers. My study of the case, however, convinces me that the report of the majority gives most inadequate consideration to the evidence presented by the defendants. I do not believe that the order will contribute materially to the public safety or that it can be justified on that ground." He concluded by stating that he was authorized to state that Chairman Miller joined in his views. Commissioners Meyer and Mahaffie did not participate.

(Turn to next left-hand page)

New Equipment Orders and Inquiries Announced Since the Closing of the January Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
Chicago & Eastern Illinois	2	600-hp.	Electro-Motive
	1	600-hp.	American Loco. Co.
Chicago, Milwaukee, St. P. & P.	6	4-6-4	American Loco. Co.

LOCOMOTIVE INQUIRIES

Alaska Railroad	1	4-6-2	
Canadian Pacific	10	Hudson	
Chicago & North Western	3	4-6-4	

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Chesapeake & Ohio	25	70-ton hopper	American Car & Fdry Co.

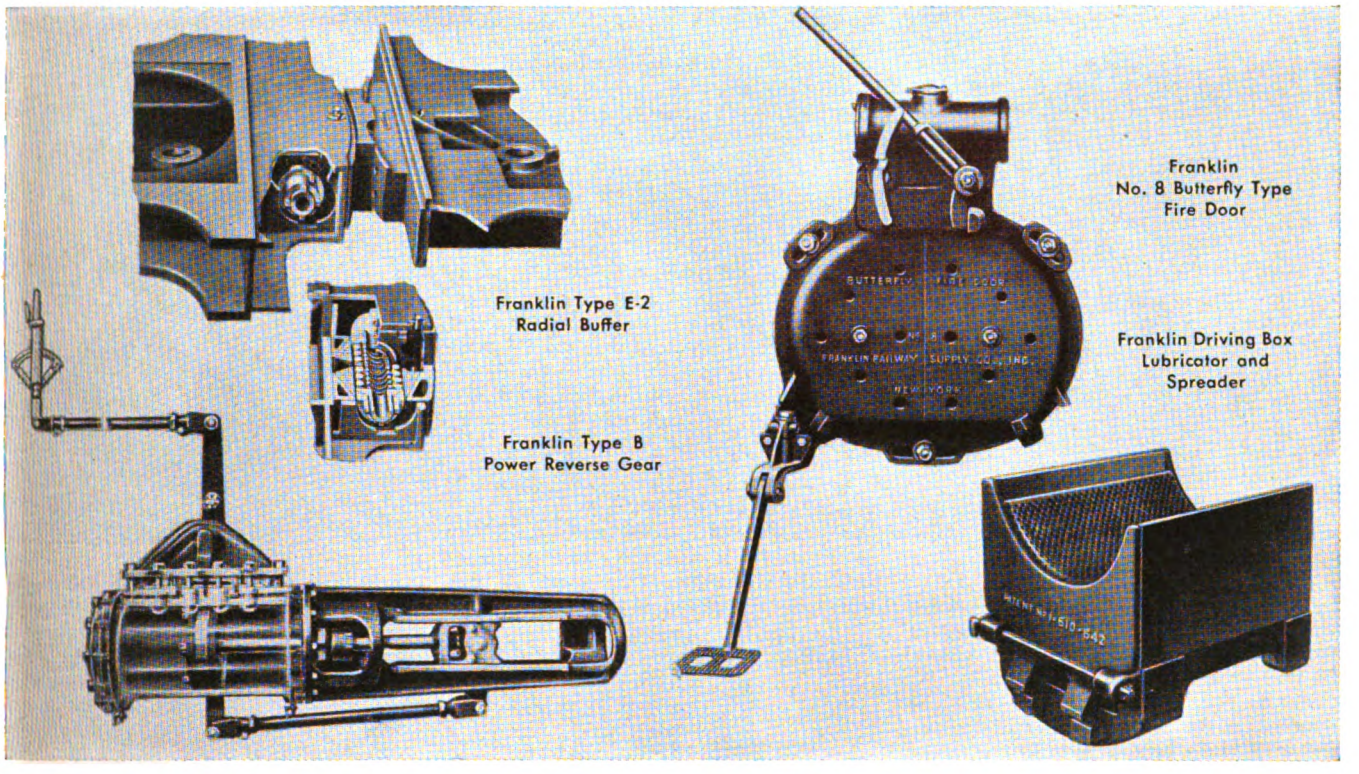
FREIGHT-CAR INQUIRIES

Canadian Pacific	2,000	40-ton box	
	200	50-ton hopper	
	200	Stone	
	100	Gondola	
	200	Flat	
Lehigh & New England	50-75	70-ton hopper	
Northern Pacific	150	Underframes	

PASSENGER-CAR INQUIRIES

Road	No. of Cars	Type of Car	Builder
Chicago & North Western	2	Passenger-baggage	
	2	Coaches	
	2	Room coaches	
	2	Cafe lounge	
	2	Dining	
	2	Observation parlor	

MODERN LOCOMOTIVE DEVICES



for modern power

The ten 2-10-2 Type Locomotives (five coal burning and five oil burning) recently delivered by Lima Locomotive Works, Incorporated, to the Kansas City Southern are equipped with Franklin Type E-2 Radial Buffers, Franklin Type B Power Reverse Gears and Franklin Driving Box Lubricator and Spreader. The five coal burning locomotives are also equipped with the Franklin No. 8 Butterfly Type Firedoor.

These devices make for easier riding, increased safety, easier handling and improved economy of operation and maintenance.

No locomotive device is better than the replacement part used for maintenance.
Genuine Franklin repair parts assure accuracy of fit and reliability of performance.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

Supply Trade Notes

E. T. SCHROEDER, 1205 Syndicate Trust building, St. Louis, Mo., has been appointed sales representative in the southwestern territory for The Burden Iron Company, Troy, N. Y.

J. M. HALL, who has been elected vice-president of the Cardwell Westinghouse Company, Chicago, as announced in the January issue of the *Railway Mechanical Engineer*, was born on February 25, 1887, at Howard, S. D., and was educated in electrical engineering at South Dakota State



(c) *Moffett Studio*

J. M. Hall

college. Mr. Hall first became associated with the railroad field as a draftsman on the Chicago & Alton (now the Alton). In 1909 he entered the employ of W. W. Cook & Son, contractors. In 1911, he returned to the Alton as chief draftsman, and in 1914 he became identified with the Babcock & Wilcox Company as chief draftsman, leaving this company two years later to become superintendent of the Hamilton Steel Wheel Company, Hamilton, Ont. In 1918, Mr. Hall became associated with Dominion Foundries & Steel, Ltd., Hamilton, as general superintendent. In 1923, he became vice-president of the Hall Draft Gear Corporation, Watervliet, N. Y., and three years later he became assistant to the president of the Universal Draft Gear Attachment Company. In 1928, he joined the Cardwell Westinghouse Company as chief engineer, which position he continued to hold until his recent election as vice-president.

C. IRVING LUSINK, assistant manager at Rochester, N. Y., of the engineering department of The Symington-Gould Corporation and the Gould Coupler Corporation, has been appointed mechanical engineer of the two companies, with headquarters, as formerly, at Rochester.

WALTER L. WOODY, manager of the Cleveland Works of the National Malleable and Steel Castings Co., Cleveland, Ohio, has been appointed manager of the Sharon, Pa., works. Charles H. McCrea, sales manager at Cleveland, succeeds Mr. Woody as manager of the Cleveland works.

R. J. VAN METER, assistant to the vice-president of the Superheater Company, with headquarters at Chicago, has also been placed in charge of sales and service for the western territories.

A. L. BERGSTROM, chief works engineer of The Timken Roller Bearing Company, Canton, Ohio, has been appointed executive engineer to co-ordinate some of the varied engineering activities of the company, following the resignation of Ernest Wooler, chief engineer.

NORMAN B. JOHNSON, assistant chief engineer of the Pullman-Standard Car Manufacturing Company, Chicago, has been appointed manager of freight shops, with temporary headquarters at the Pullman Car Works. Mr. Johnson will have general jurisdiction over all freight plant production activities.

THEODORE R. WEBER, mechanical engineer of the Railway Steel-Spring Division of the American Locomotive Company, with headquarters at Latrobe, Pa., has been appointed chief mechanical engineer, succeeding Alan N. Lukens, deceased, and Bennett Burgoon, Jr., assistant mechanical engineer, has been appointed mechanical engineer, to succeed Mr. Weber.

T. M. ROBIE, who has been appointed manager of the Diesel engine sales division of Fairbanks, Morse & Co., with headquarters at Chicago, was graduated from the University of Michigan in 1914, where he specialized in the study of in-



T. M. Robie

ternal combustion engines. Later he was employed by the General Electric Company on locomotive tests and on the development of high-speed opposed-piston Diesel generating sets for stationary and Diesel-electric railway locomotive application. For two years he operated Diesel power plants in New Mexico. Upon returning from the World War Mr. Robie became associated with Fairbanks, Morse & Company, during which time he was associated with the New York branch office for one year, and the Dallas office for two years and was employed at the factory on Diesel engine designing, testing and building for nine years. Since 1932 he has been in charge of Diesel sales to resale manufacturers.

EARLE A. MANN, district sales manager of the Standard Brake Shoe & Foundry Company, Pine Bluff, Ark., with headquarters at Chicago, has been appointed director of sales at Pine Bluff.

CARL H. BECK, eastern manager of the Westinghouse Air Brake Company, has been appointed general sales manager, with headquarters at the general office, Wilmerding, Pa. Mr. Beck was graduated from the Pennsylvania State College in 1905, as a bachelor of science, and six



Carl H. Beck

years later received the degree of mechanical engineer from the same college. A few weeks after graduation he entered the employ of the Westinghouse Air Brake Company as a special apprentice and served on a number of shop and field assignments until 1907, when he was appointed steam road inspector at the St. Louis, Mo., office. In 1909 he became representative for the Westinghouse Traction Brake Company in St. Louis, a position he held until 1919 when he was appointed special representative of the Safety Car Devices Company at Wilmerding. Mr. Beck's next promotion came the following year when he was appointed assistant eastern manager of the Westinghouse Air Brake Company. In 1932 he was given full responsibility of the eastern district as manager.

A. E. BIDDLE, recently elected executive vice-president of the Cardwell Westinghouse Company, Chicago, as announced in the January issue of the *Railway Mechanical Engineer*, was born on April 27, 1893, at Chicago, and completed his high-school education at that point. He first became identified with the railroad supply field in 1909, when he entered the engineering department of W. H. Miner, Inc., Chicago. While he was serving with this company, Mr. Biddle took an evening course in mechanical engineering at the Armour Institute of Technology. After spending 10 years in the engineering department of W. H. Miner, Inc., Mr. Biddle was transferred to the sales department, where he remained for another 10 years, his service with this company being interrupted only

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NO. 11 OF A SERIES OF FAMOUS ARCHES OF THE WORLD



Photo by Coxe, Greenville, S. C.

POINSETT ARCH BRIDGE

SOUTH CAROLINA 1820

One of the most interesting of the early bridges in this country is the Poinsett Bridge located at Callahan Mountain, 25 miles from Greenville, South Carolina. This stone arch bridge was constructed under the supervision of Joel Roberts Poinsett in 1820 at which time he was Chairman of the South Carolina Board of Public Works. It is a part of the Saluda Mountain Road and but one of a number of internal improvements which he initiated in his native state. The bridge is 125 feet in length and about 30 feet in height. Parapets on either side rise up some 6 feet. It is in active use today, accommodates one vehicle at a time and the stone work is as sound today as when it was first built.

Joel Roberts Poinsett, was a noted diplomat, statesman and engineer. Widely traveled and a keen student of politics throughout the world, he served successively in the State Legislature, the Federal House of Representatives, was the first American Minister to Mexico, and was Secretary of War under President Van Buren. In 1841 he retired to his South Carolina plantation. The wide variety of his interests is indicated to some degree by his contribution to the National Institute for the Promotion of Science and Useful Arts; his gifts of manuscripts to the American Philosophical Society and the Pennsylvania Historical Society; and the beautiful Poinsettia, which he brought into this country and developed from a Mexican plant.

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
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Locomotive Combustion Specialists

during the World War when he served 16 months with the United States Army, 11 months of which were spent overseas. In November, 1930, Mr. Biddle was elected



(c) *Moffett Studio*

A. E. Biddle

executive vice-president of the Universal Draft Gear Attachment Company, being elected president and a director of that company in February, 1932. In June of the same year he was elected also vice-president and a director of the Allied Steel Castings Company, and in January, 1934, was elected also vice-president of the Canadian Cardwell Company. In February, 1935, he became vice-president of the Cardwell Westinghouse Company, this position being also in addition to those mentioned previously. In his capacity as executive vice-president of the Cardwell Westinghouse Company, Mr. Biddle retains his connection with the Universal Draft Gear Attachment Company, the Allied Steel Castings Company and the Canadian Cardwell Company.

JAMES C. YOUNGLOVE has been appointed general sales manager of the American Hair & Felt Company and manager of the railroad and government division of this company and its subsidiary, the Dry-Zero Corporation. Mr. Younglove entered the em-



J. C. Younglove

ploy of the Johns-Manville Corporation in January, 1902. Shortly thereafter he assisted in organizing the railroad sales department of that company. Later he served as a director of the company. On August 1, 1931, he entered the employ of the American Hair & Felt Company as head of the railroad and government division and in December, 1937, was appointed general sales manager, retaining his position as manager of the railroad and government division.

BARD BROWNE, who has been elected a vice-president of The Superheater Company, New York, as announced in the January issue of the *Railway Mechanical Engineer*, was born at Sedalia, Mo., on February 17, 1887, and in 1904 was graduated from high school. Soon after graduation he entered the employ of the Missouri Pacific at Kansas City, Mo., as a locomotive fireman. Early in 1905 he became a locomotive fireman on the Chicago & North Western, Nebraska and South Dakota divisions, later being promoted to engineman. Desiring to continue his studies, he left railroad work in 1908 to enter school in



Bard Browne

Philadelphia, Pa., at the same time serving a special apprenticeship at the Baldwin Locomotive Works. In 1913 he went to the Antipodes and the Far East as a special representative of the company. Upon returning to America in 1915 he was assigned to duties in the St. Louis, Mo., office and was later transferred to the new erecting shop at Eddystone, Pa. Mr. Browne became associated with The Superheater Company in 1916, and 10 years later was appointed assistant to vice-president, which position he held until his recent election as vice-president.

N. T. MCKEE, who has been elected a vice-president of The Superheater Company. New York, as noted in the January issue of the *Railway Mechanical Engineer*, was born on January 7, 1882, at Mt. Sterling, Ky. His education was obtained from private schools in Mt. Sterling, and at the University of Kentucky, from which he received the degree of B. M. E. in 1903 and his M. E. degree in 1906. Mr. McKee entered railway service in 1903 as a special apprentice with the Lake Shore & Michigan Southern (now part of the New York Central), finishing his apprenticeship in 1906. In 1906 and 1907 he served as assistant mechanical engineer and then as a locomotive shop foreman on the same road. In 1908 he entered the automobile sales business in his home town, Mt. Sterling, Ky., where he remained until 1911, when he joined The Superheater Company. During 1920-1922, he was assigned to special development work with The Superheater Company, Ltd., of London, an associate company. Shortly after his return from



N. T. McKee

England he became active in locomotive service work and previous to his becoming vice-president he was general service manager of the locomotive division of The Superheater Company.

DAVID F. AUSTIN, manager of sales of the Chicago district of the Carnegie-Illinois Steel Corporation, has been elected vice-president in charge of sales, to succeed C. V. McKaig, who has been elected vice-president of the United States Steel

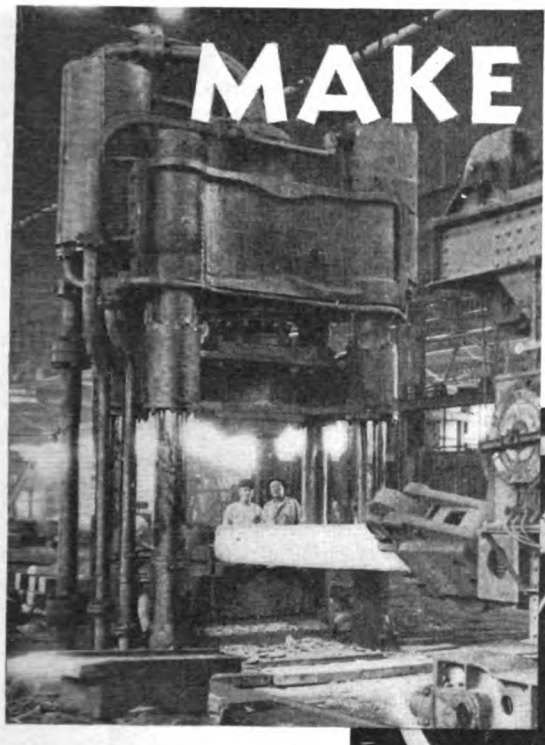


David Austin

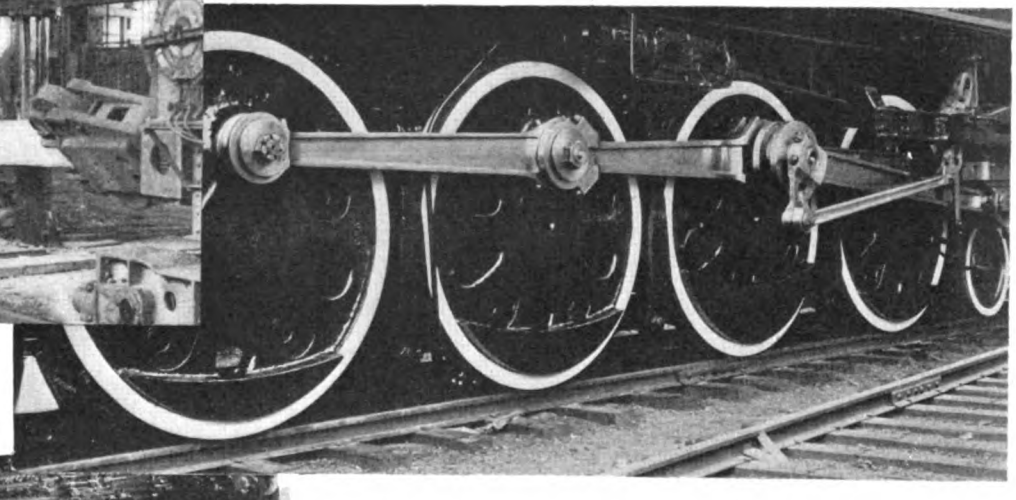
Corporation of Delaware, and has been succeeded by Philip M. Guba, manager of sales at the Detroit district sales office. Mr. Guba has been succeeded by Francis C. Hardie, manager of sales of the Cleveland district sales office, who in turn has been succeeded by F. Royal Gammon. Thomas J. Hilliard, manager of sales of the Pittsburgh district sales office, has been appointed general manager of sales at Pittsburgh, Pa., and has been succeeded by Thomas J. Bray, Jr.

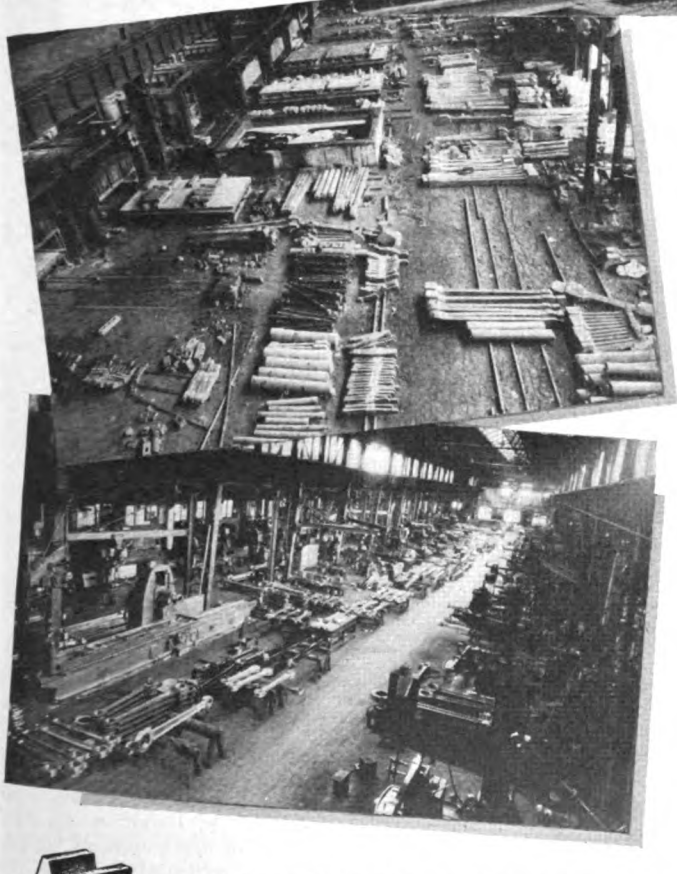
David F. Austin's entire business career has been with the United States Steel Corporation subsidiaries. After leaving Columbia University in 1920, he spent seven

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MAKE *Every* DOLLAR DO FULL DUTY *Specify* ALCO FORGINGS

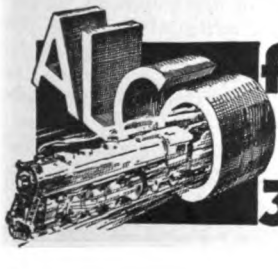




ALL DOLLARS spent for forgings are not equal in value after they are spent. Money spent for forgings, that have demonstrated their ability to last longest in hard service, give utmost protection against engine failures, reduce the cost of running and classified repairs, will unquestionably give greatest return per dollar. That's exactly how ALCO Forgings have performed for many years—they have added dependability to and reduced the cost of operating thousands of locomotives.

ALCO Forgings are economical also, because you get this extra value, strength and durability at less cost than you can equip, maintain and operate your shops to manufacture forgings of similar high quality.

Stick to quality—make every dollar do full duty—specify ALCO Forgings.



AMERICAN LOCOMOTIVE COMPANY

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years in the Youngstown district with the Carnegia-Land Company and the Conneaut Land Company. In 1927 he joined the Carnegie Steel Company's sales department in the Pittsburgh district and shortly thereafter was transferred to Cincinnati, where, in May, 1931, he became assistant manager of sales. In November of the same year he became manager of sales at Cincinnati. Two years later he was appointed manager of sales of the Pittsburgh district office and in November, 1935, was transferred to Chicago, where he became manager of sales of the Chicago district.

Philip M. Guba became associated with the Carnegie-Illinois Steel Corporation in March, 1933, as assistant manager of sales at the Detroit district sales office and was appointed manager of sales at that office in March, 1935. He has been connected with the selling end of the steel industry since 1910, having served 22 years with Jones & Laughlin, the Donner Steel Company



Philip M. Guba

and the Republic Steel Corporation prior to his association with Carnegie-Illinois.

Thomas J. Hilliard was born at Pittsburgh on March 3, 1894. He attended St. Paul's school, Concord, N. H., and was graduated from Princeton University with an A.B. degree in 1917. From college, Mr. Hilliard entered the U. S. Army Air Service as a private in May, 1917, and subsequently was advanced to the rank of first lieutenant. He completed his army air service with the rank of captain in February, 1919. Mr. Hilliard was president of the Carhile Petroleum Company of Pittsburgh, from September, 1919, to January 1, 1922; then president of the Pittsburgh Oil & Refining Co., serving in that



Thomas J. Hilliard

capacity until 1926, and from January 1, 1926, until June 1, 1930, he was president of the Waverly Oil Works Company, Pittsburgh. From April, 1931, to September, 1932, he was sales manager and vice-president of the O. Hammell Company, Pittsburgh, and then to April, 1935, was vice-president of the Standard Steel Spring Company, Cora, Pa. Mr. Hilliard joined the Carnegie-Illinois Steel Corporation as manager of sales of the Pittsburgh district office, on January 1, 1936, and on January 1, 1938, was appointed general manager of sales.

Obituary

DAVID J. WILKOFF, president of the Youngstown Steel Car Corporation, Niles, Ohio, died suddenly on January 7.

B. J. MORRISON, for many years chief engineer of the Coale Muffler & Safety Valve Co., Baltimore, Md., died suddenly on January 2, at his home in Baltimore.

ROBERT S. BROWN, vice-president and treasurer of the G. M. Basford Company, advertising agents, New York, and an advertising executive who was well known in the railway supply field, died unexpectedly at his home in Rutherford, N. J., on January 17. Mr. Brown was 51 years of age at the time of his death and had been connected with the G. M. Basford Company since 1916. He was born in England but came to this country in his early life. After attending public schools of East Rutherford, N. J., and high school, he went to Pratt Institute, Brooklyn, N. Y., where he was graduated in the class of 1909. He then entered the service of the Erie Railroad as a special apprentice, working successively in the Meadville, Pa., office of the mechanical engineer, in the Erie shops at Susquehanna, the office of the general mechanical superintendent at New York and the office of the purchasing agent at New York. He left to become associated with the Simmons-Boardman Publishing Corporation in its advertising production division, and later was engaged in work on the Locomotive Cyclopedia and the Car Builders' Cyclopedia, published by Simmons-Boardman, leaving in 1916 to join the G. M. Basford Company. In recent years, Mr. Brown specialized on merchandising problems in



Robert S. Brown

the railway supply industry, including work for the American Arch Company, the Franklin Railway Supply Company, the Lima Locomotive Works, The Superheater Company, the Standard Stoker Company, and others. He was a member of the Engineers' Club, the Transportation Club and the New York Railroad Club.

Personal Mention

General

F. K. MITCHELL, master mechanic of the New York Central System, at Indianapolis, Ind., has been appointed assistant superintendent of equipment.

T. C. BALDWIN, master mechanic of the New York, Chicago & St. Louis at Conneaut, Ohio, has been appointed superintendent of motive power, with headquarters at Cleveland, Ohio.

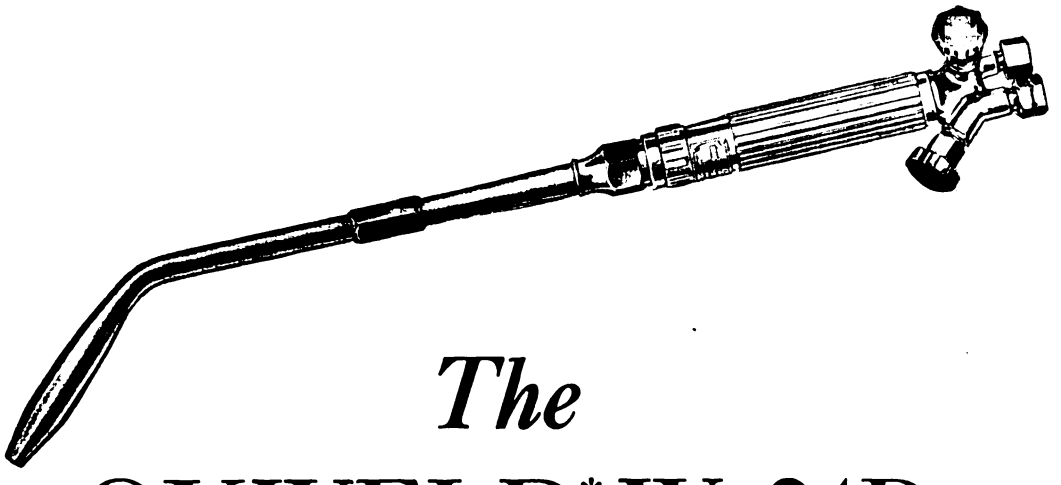
H. L. BONSTEIN, chief draftsman in the office of the mechanical engineer of the Lehigh Valley, at Bethlehem, Pa., has been promoted to the position of mechanical engineer, with headquarters at Bethlehem, succeeding W. I. Cantley.

W. R. SUGG, superintendent of fuel conservation of the Missouri Pacific, has had his jurisdiction extended to cover the lubrication of locomotives.

F. K. MURPHY, assistant superintendent of equipment of the New York Central System at Indianapolis, Ind., has been appointed superintendent of equipment, with the same headquarters, to succeed D. J. Mullen, retired.

D. J. MULLEN, superintendent of equipment of the New York Central System at Indianapolis, Ind., has retired after 55 years' service with the company. Mr. Mullen was born on December 14, 1867, at Cincinnati, Ohio, and completed his education at Ohio Mechanical Institute. He entered railway service on November 17, 1882, as a machinist apprentice on the Cleveland, Cincinnati, Chicago & St. Louis (part of the New York Central System). Subsequently he was made a machinist and later served successively as gang foreman,

(*Continued on next left-hand page*)



The
OXWELD* W-24R
WELDING BLOWPIPE

The Blowpipe for All Railroad Welding

THE Oxweld W-24R is an all-purpose oxy-acetylene welding blowpipe for railroads. Some of the important uses of this blowpipe include the repair of broken cylinders, frames and wheel centers, the building up of worn piston heads and driving-box surfaces, and the butt-welding of rail.

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enginehouse foreman at Cincinnati, and general foreman at Brightwood, Ind. In 1904 he was appointed master mechanic at Mt. Carmel, Ill., and in November, 1912, was transferred to Mattoon, Ill. Two years later Mr. Mullen was promoted to assistant superintendent of motive power, and in March, 1914, became superintendent motive power at Indianapolis. He had been superintendent of equipment since 1934.

Master Mechanics and Road Foremen

OSCAR G. PIERSON, who has been appointed master mechanic of the Oklahoma and Southern Kansas Division of the Atchison, Topeka & Santa Fe at Arkansas City, Kan., was born on June 1, 1889, at



O. G. Pierson

Topeka, Kan. He left school in June, 1906, and on April 30, 1907, entered the employ of the Santa Fe as a machinist apprentice at Topeka. He completed his apprenticeship on July 13, 1911, and worked as a machinist until April 1, 1912, when he became foreman of the air-brake room. He was transferred to Argentine, Kan., as a machinist gang foreman on September 2, 1914. On February 20, 1916, he became night enginehouse foreman at Arkansas City and on January 28, 1917, night enginehouse foreman at Argentine. Mr. Pierson resigned on March 17, 1918, to work in the navy yard at Washington, D. C. He returned to the Santa Fe on January 4, 1919, as a machinist at Argentine; on February 8, 1919, became machinist gang foreman; on June 19, 1919, air-brake foreman, and on March 3, 1920, enginehouse foreman. He became general foreman at Arkansas City on November 1, 1920, and district master mechanic on September 1, 1937.

J. J. MELLEN has been appointed master mechanic of the New York Central System with headquarters at Indianapolis, Ind., to succeed F. K. Mitchell.

W. R. WITHERSPOON, master mechanic of the Atlantic Coast Line at High Springs, Fla., has been appointed master mechanic, with headquarters at Florence, S. C., succeeding J. H. Painter, retired.

T. C. SHORTT, assistant to superintendent of motive power of the New York, Chicago & St. Louis, has been appointed master mechanic of the Nickel Plate district, succeeding T. C. Baldwin.

FRANK J. REGAN, road foreman of engines at Minneapolis, Minn., has been appointed master mechanic of the Yellowstone division of the Northern Pacific, with headquarters at Glendive, Mont., to succeed W. D. Gochenour.

A. T. MILLER, assistant to superintendent motive power and general storekeeper of the Atlanta & West Point, the Western Railway of Alabama, and the Georgia railroad, with headquarters at Atlanta, Ga., has been appointed master mechanic of these roads, with headquarters at Montgomery, Ala., and Augusta, Ga. On the latter road Mr. Miller succeeds O. H. Attridge, who has retired, and on the former roads he succeeds E. G. Gross, retired.

Car Department

A. J. KRUEGER has been appointed superintendent of the car department of the New York, Chicago & St. Louis, succeeding W. M. Wheatley, who has been assigned to other duties.

M. J. LACOURT, general car foreman of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Milwaukee, Wis., is retiring at his own request after 40 years' service with the Milwaukee.

P. P. BARTHELEMY, whose appointment as master car builder of the Great Northern, at St. Paul, Minn., was reported in the January *Railway Mechanical Engineer*, has been in the service of the Great Northern for over 36 years. After attending the University of Minnesota, Mr. Barthelemy entered the service of the



P. P. Barthelemy

Great Northern as a mechanic in the shops at St. Cloud, Minn. He advanced successively through the positions of air brake foreman and assistant car foreman, later becoming car foreman at the Hillyard shops (Spokane, Wash.). From 1915 to 1917 he was engaged in car valuation work, then being appointed, successively, assistant general car foreman, general car foreman, assistant master car builder, and master car builder. Mr. Barthelemy is active in railway association work. He has served as president of the Northwest Car Men's Association, and is now director and a member of the Lubrication committee of the Car Department Officers' Association.

M. L. HYNES has been appointed general car department supervisor of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Milwaukee, Wis., succeeding M. J. Lacourt.

E. F. PALMER, district car foreman of the Chicago, Milwaukee & St. Paul at Green Bay, Wis., has been appointed general car foreman with headquarters at Milwaukee, Wis., succeeding M. L. Hynes.

Shop and Enginehouse

L. M. CORNELL, enginehouse foreman of the Atlantic Coast Line at High Springs, Fla., has been appointed acting general foreman.

DONALD L. BRIGHTWELL, gang foreman of the Chesapeake & Ohio at Hinton, W. Va., has been promoted to the position of general foreman.

A. J. PICHETTO has been appointed general air-brake, steam-heat and lubrication engineer of the Illinois Central, with headquarters at Chicago, to succeed Emil Von Bergen.

WARREN D. GOCHENOUR, master mechanic of the Northern Pacific at Glendive, Mont., has been appointed shop superintendent at Livingston, Mont., to succeed Thomas Jackson, who has retired after 42 years with the Northern Pacific.

JOHN MATTISE, fuel supervisor of the Chicago & North Western, with headquarters at Chicago, has been appointed general air brake instructor with the same headquarters, to succeed William J. Devine, who has retired. Mr. Mattise has also been assigned to exercise general supervision over motive power lubrication.

FRANK T. MCCLURE, road foreman of engines on the Panhandle division of the Western lines of the Atchison, Topeka & Santa Fe, with headquarters at Wellington, Kan., has been promoted to supervisor of air brakes, with headquarters at Amarillo, Tex., succeeding F. C. Smith, who is retiring on pension after 32 years' service with the Santa Fe.

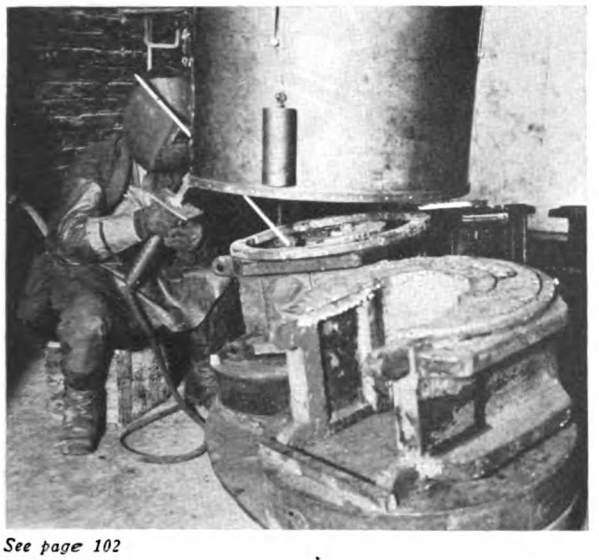
Obituary

A. G. SANDMAN, retired assistant to chief of motive power and equipment of the Baltimore & Ohio, died at his home in Baltimore, Md., on January 9. Before being pensioned on May 1, 1932, Mr. Sandman had been in active service of the Baltimore & Ohio for more than 52 years, during nearly all of which he was stationed at the Mount Clare shops in Baltimore. He was born October 19, 1862, in Germany, and was educated in the public schools of Baltimore county, Md., and Maryland Instltute, Baltimore. Mr. Sandman entered the service of the Baltimore & Ohio as a machinist apprentice on October 7, 1879, becoming a machinist in 1883. Five years later he became a draftsman, being promoted to chief draftsman in 1901. For eight years, from July 16, 1918, to November 1, 1926, he was mechanical engineer. He was appointed assistant to chief of motive power and equipment on the latter date.

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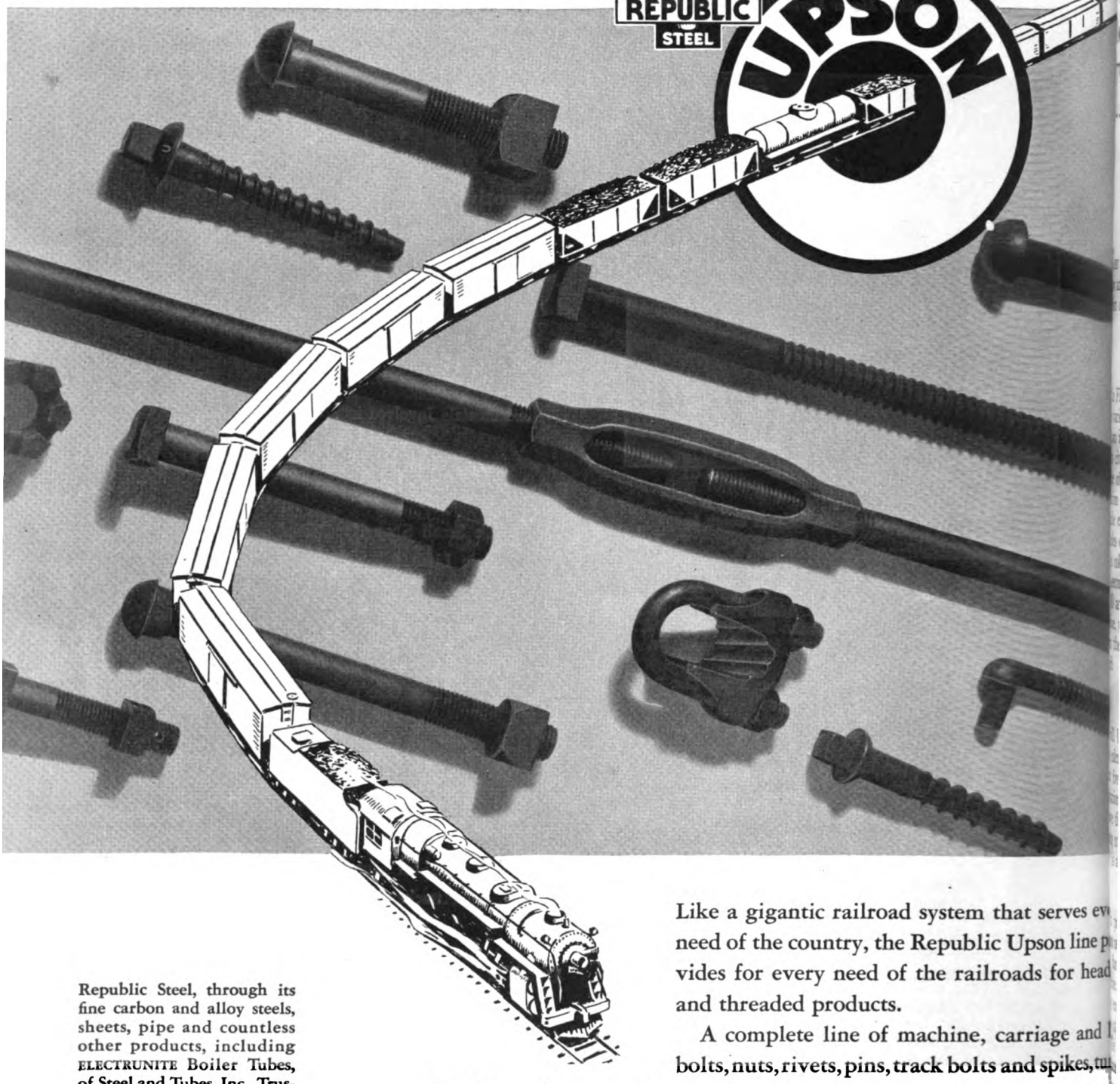
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A Study, Based on Laboratory Results, of

The Locomotive Front End

Part III*

By H. S. Vincent

An investigation of the laws which govern the flow of steam and gas in a locomotive front end—The author discusses the feasibility of reducing back pressure in locomotive cylinders

Area of Nozzle

THE area of the nozzle for any combination of steam flow and back pressure may be determined by a transposition of equations (6) and (7), in which

$$A_2 = \frac{M_o V_2 \sqrt{Z}}{223.7 \sqrt{\Delta H C}} = \frac{M_o V_2}{W} \quad \ldots\ldots\ldots\ldots\ldots\ldots (23)$$

In Fig. 24 is shown the relation between M_o and A_2 for various increments of ΔP as derived from the curves shown in Figs. 5 to 12, inclusive. Within range of the tests cited, it is apparent that the steam flow for any value of ΔP increases in approximately a straight-line relation to the nozzle area, independently of the type of nozzle employed. Young [1]** found that this true for nozzles of similar form.

In column 8 of Table VII is given the steam flow per second per pound of ΔP for a constant value at $\Delta P = 10$ as derived from the curves in Figs. 5 to 12, inclusive, while in column 14 is given the flow as estimated from the equation in Fig. 24 applying to $\Delta P = 10$, in which

$$M_o = 3.75 + (35.1\ A_2)$$

It will be observed from column 15 of Table VII that the calculated flow in no case varies more than 4.1 per cent from the actual flow, and in most instances the variation is much less. This exhibit would seem to prove the statement that, within the range of the tests being considered, the steam flow for any given value of ΔP is a straight-line function of the nozzle area.

Reducing Back Pressure

In present locomotive practice, the area of the exhaust nozzle is based on a certain proportion of the tube and flue area, or in some cases on the cylinder area or volume. These empirical rules have been established from long experience, and the resulting operation is more or less satisfactory.

The Master Mechanics front-end arrangement, using a circular nozzle, is in almost universal use for coal-burning locomotives in the Americas. With this combination, and in fact with any other arrangement, once the correct area of the nozzle has been established, it cannot be changed without affecting the steaming capacity of the locomotive or varying the cylinder horsepower output.

It has been shown in Fig. 22 that, by a change in the type of nozzle and in the front-end arrangement of a locomotive, considerable improvement can be effected in steaming capacity without a corresponding drop in cylinder power. This is brought about by better entrainment of the gases and by a reduction in the resistance to gas flow, without seriously affecting the self-cleaning function of a front-end apparatus.

By taking, for example, locomotive *A* which is equipped with a modern and efficient type of nozzle and

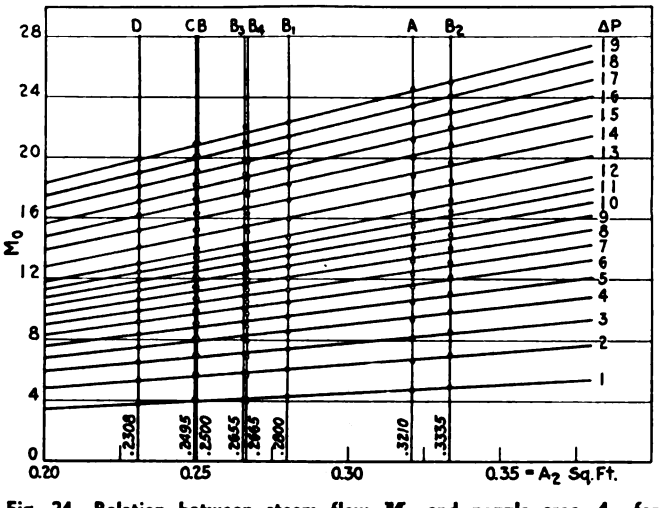


Fig. 24—Relation between steam flow M_o and nozzle area A_2 for various increments of ΔP

Value of ΔP	Equation	Value of ΔP	Equation	Value of ΔP	Equation
1	1.18 + 11.11	8	3.24 + 31.79	15	5.94 + 44.30
2	1.60 + 16.00	9	3.55 + 33.30	16	6.24 + 46.92
3	2.06 + 19.24	10	3.75 + 35.12	17	7.12 + 47.40
4	2.30 + 22.52	11	3.98 + 36.66	18	7.55 + 49.55
5	2.44 + 25.45	12	4.05 + 38.75	19	8.15 + 50.70
6	2.76 + 27.69	13	4.65 + 40.70		
7	3.11 + 29.45	14	5.49 + 42.00		

(To find M_o at $\Delta P = 10$: $M_o = 3.75 + (35.12\ A_2)$

front-end arrangement, it will be shown what is involved in attempting a further reduction in back pressure in this locomotive. It will be seen from Figs. 5 and 5*C* that with the existing apparatus the weight of gas moved per second over the heating surfaces is $W_g = 38.75$ lb., requiring a steam flow M_o *of* 20 lb. per sec. through the nozzle; this necessitates a back-pressure equivalent of $\Delta P = 15$. It will now be assumed that

* Parts I and II of this article were published in the January and February issues, respectively.
** Footnotes 1 to 5, inclusive, were published with Parts I and II of this article.

ΔP is reduced to 12, using the quantities shown in Table V for this pressure. From equation (23)

$$A_2 = \frac{20 \times 29.14 \times \sqrt{Z}}{223.7 \times 7.119 \times C}$$

If we assume no change in A_1 from that given in column 3 of Table IV for locomotive A, then

$$Z = 1 - \left(\frac{18.41}{29.14}\right)^2 \left(\frac{A_2}{0.959}\right)^2$$

and from equation (12) $C = 1.1075 - 0.606\ A_2$; however, both Z and C require A_2 for their solution. From Fig. 24 we obtain the approximate value of A_2 by the equation

$$A_2 = \frac{20 - 4.05}{38.75} = 0.41 \text{ sq. ft.}$$

Then $Z = 1 - (0.398 \times 0.1826) = 0.9274$, and $C = 1.1075 - (0.606 \times 0.41) = 0.859$. Therefore

$$A_2 = \frac{20 \times 29.14 \times \sqrt{0.9274}}{223.7 \times 7.119 \times 0.859} = 0.41 \text{ sq. ft.}$$

which checks the approximate value of A_2 as found from Fig. 24.

It has been shown by Fig. 22 that for any type of nozzle $W_g\ a\ \sqrt[3]{A_2}$; therefore the gas flow for a nozzle having an area of 0.41 sq. ft. is

$$W_g = \frac{32.75 \times \sqrt[3]{0.41}}{\sqrt[3]{0.321}} = 35.5 \text{ lb.}$$

In reducing ΔP from 15 to 12 lb. or 20 per cent, the gas flow has been decreased from 38.75 lb. to 35.5 lb., or 8.3 per cent.

It has been shown elsewhere[6] that locomotive A, when working at the rating assumed in the example, transfers about 60 per cent of the available heat through the tubes and superheater. Therefore, the loss in evaporation is 0.6 x 8.3 = 4.98 per cent. Since approximately 13 per cent of the heat transferred in the boiler is converted into work in the cylinder, the loss in cylinder power is also 4.98 per cent.

The reduction of 1 lb. in back pressure adds from 0.5 to 2 per cent to cylinder horsepower, depending on the cutoff. For an assumed cutoff of 50 per cent, the reduction of 3 lb. in the value of ΔP, as assumed in the foregoing example, represents a gain of 3 per cent in cylinder work. Therefore, the net loss is 4.98 — 3 = 1.98 per cent. Any further reduction in the value of ΔP would result in a greater cylinder loss, so there is apparently nothing to be gained in this case by simply enlarging the nozzle.

A reduction in back pressure without involving loss in cylinder output can be effected only by a further improvement either in the contour of the nozzle or in the design of the drafting apparatus to reduce gas resistance, or in both.

It has been shown in Fig. 20 that, in the model test, an increased air movement was effected by the application of a four-hole pepper-box nozzle in conjunction with a gyratory spark arrestor, over that obtained with a 1½-in. circular nozzle and Master Mechanics standard smokebox arrangement. It is reasonable to assume that the same percentage of increase could be maintained in the actual locomotive.

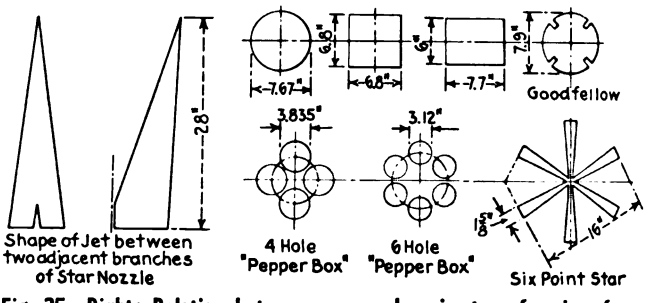


Fig. 25—Right: Relation between area and perimeter of various forms of locomotive exhaust nozzles, all having equal area. Left: Development of jet between two branches of the six-point star nozzle

It is shown in Fig. 22 that with a Goodfellow nozzle having an area of 0.321 sq. ft., in conjunction with a Master Mechanics front-end arrangement, locomotive A will move 28.8 lb. of gas per sec. when $\Delta P = 14$. If this locomotive were equipped with a four-hole pepper-box nozzle of the same area, operated in combination with a GB gyratory spark arrestor, the gas moved would be 28.8 x 1.276 = 36.75 lb. per sec. The six-point star nozzle and type of drafting apparatus shown in Fig. 1 for the locomotive A moves 37 lb. of gas per sec. using the same values of ΔP and M_0 assumed in the foregoing example. Therefore, both arrangements show about equal efficiency.

In Table VIII is shown the cylinder loss or gain incurred by increasing the area of the nozzle of locomotive A, but without changing the steam flow. It will be seen that for any increase in the nozzle area above 0.34 sq. ft. a cylinder loss is involved. At a nozzle area of 0.338 sq. ft. there is a small gain in the cylinder output. The indication from this exhibit is that the nozzle of loco-

Table VII—Variation in Fuel Consumption, Gas and Steam Flow in Actual Operation of the Eight Locomotives when ΔP Remains Constant at 10

1	2	3	4	5	6	7	8	9	10[a]	11[a]	12[b]	13[a]	14[c]	15
Locomotive	Fuel fired, lb. per sq. ft. grate surface per hr.	Gas flow through boiler, lb. per sec.	Lb. of gas per lb. of steam, C_s	ΔP	P_1	Steam flow at ΔP, lb. per sec.	Steam flow per lb. of ΔP, lb. per sec.	Gas flow per lb. of ΔP, lb. per sec.	Gas flow, per cent	Steam flow, per cent	Col. 8/ (nozzle area), lb.	Percentage of col. 12	Steam flow per lb. of ΔP, lb. per sec.	(Col. 14 — col.) ÷ col. 8
A	139.0	30.15	2.04	10	24.7	14.77	1.477	3.015	136.5	115.5	0.0460	90.0	1.501	+1.5
B	90.2	22.10	1.73	10	24.7	12.78	1.278	2.210	100.0	100.0	0.0511	100.0	1.252	-2.1
B_1	98.0	25.80	1.91	10	24.7	13.50	1.350	2.580	117.0	105.6	0.0482	94.2	1.358	+0.6
B_2	118.0	28.57	1.82	10	24.7	15.70	1.570	2.875	129.3	122.9	0.0481	94.0	1.546	-1.5
B_3	90.0	20.20	1.56	10	24.7	12.97	1.297	2.020	91.4	101.5	0.0489	95.7	1.307	+0.8
B_4	97.0	20.15	1.60	10	24.7	12.60	1.260	2.015	91.2	98.5	0.0473	92.6	1.311	+4.1
C	119.8	22.25	1.74	10	24.7	12.78	1.278	2.225	100.7	100.0	0.0512	100.2	1.251	-2.2
D	83.0	24.35	2.05	10	24.7	11.86	1.186	2.435	110.2	92.8	0.0514	100.6	1.185	-0.1

Note: [a] Basis = 100 per cent. [b] Nozzle area, sq. in. [c] Estimated from Fig. 24.

[6] "Heat Transmission in Locomotive Boilers," by H. S. Vincent, *Railway Mechanical Engineer*, vol. 109, May, June and August, 1935, pages 180, 228 and 335, respectively. Refer to locomotive M1a.

motive A could be increased with advantage from its present area of 0.321 sq. ft. to 0.34 sq. ft.

It has been shown that little can be accomplished in facilitating the movement of combustion gases by a mere change in the nozzle area, any improvement in the gas movement being accompanied by a corresponding increase in the exhaust pressure. It is also evident that

Table VIII—Effect of Increasing Nozzle Area, with Constant Steam Flow, for Locomotive A

M_o, lb.	A_2, sq. ft.	V_2, cu. ft.	$\sqrt{\Delta H}$, lb.	Z	C	ΔP	W_g	Loss in steaming capacity of boiler per cent	Net cylinder loss or gain, per cent
20	0.321	23.91	7.214	0.955	0.903	15.0	38.75	...	...
20	0.347	25.41	7.175	0.949	0.890	14.0	38.00	1.16	0.16 loss
20	0.367	26.55	7.156	0.942	0.876	13.5	37.60	1.78	0.28 loss
20	0.373	27.07	7.138	0.939	0.872	13.05	36.90	2.88	0.88 loss
20	0.410	29.14	7.119	0.927	0.858	12.0	35.52	4.98	1.98 loss
20	0.338	24.78	7.17	0.951	0.891	14.4	38.40	0.54	0.06 gain
21	0.321	....	....	....	....	15.5	39.50	...	...
21	0.340	....	....	....	....	15.0	39.50	...	...

Note: For definition of terms in column headings and their units, see Table III.

by a change in the nozzle contour a considerable improvement in front-end operation can be secured.

In Fig. 25 is shown diagrammatically the various shapes of nozzles here discussed, all having the same area; the essential dimensions and ratios are given in Table IX. There is evidently an important relation between the weight of gas moved in unit time and the ratio between the area and the perimeter of the jet. This ratio is least for the circular nozzle and greatest for the six-point-star type, the ratio for the latter being four times that of the circular nozzle. The second best ratio is given by the six-hole pepper-box nozzle.

It cannot be assumed that the relative gas movement will be proportional to the perimeter-area ratio of the nozzle, since the relative ratios of the resulting jets may be quite different from that of the nozzles. It may be said that the more nearly any form of jet approaches the circular, the less efficient it will be. For this reason the six-hole pepper-box nozzle has been found less efficient than the four-hole type.

It would be possible, for example, to scallop the edge of the circular nozzle, thus obtaining a better perimeter ratio, but the resulting jet at a point a few inches above the nozzle would return to the circular form. We may then with reason conclude that the nozzle whose shape is such that it effects the deepest convolutions in the jet

Table IX—Geometrical Relations of Various Shaped Nozzles, All Having Equal Area

	Area sq. in.	Perimeter, in.	Perim. / Area	Mean hydraulic radius	Diam., in.
Plain circular	46.2	24.1	0.521	1.920	7.670
Square, 6.8 in.	46.2	27.2	0.588	1.700	....
Rectangle, 6 x 7.7 in.	46.2	27.4	0.593	1.685	....
Four-hole pepper box..	46.2	48.2	1.043	0.958	3.835
Six-hole pepper box...	46.2	58.8	1.273	0.785	3.120
Goodfellow	46.2	36.3	0.786	1.270	7.900
Six-point star	46.2	100.0	2.166	0.462	....

is the most efficient. Of the nozzles shown in Fig. 25, the six-point star has the largest perimeter ratio and is of such contour that the resulting jet retains its original shape for a considerable portion of its traverse between the nozzle and the stack, thereby offering the maximum surface area for entrainment of the gases.

Also shown in Fig. 25 is the shape of the jet between two adjacent branches of the six-point nozzle, assuming a jet flare of 7 deg. It will be seen that the jet forms a tent-like convolution extending from 3 in. at the center to about 28 in. at the periphery above the nozzle, or at the meeting point of the steam from the two adjacent openings. It has been shown that the jet from the star nozzle still retains its rococo shape when it comes into contact with the stack.

In the conventional type of locomotive, with any given design of nozzle or front end, a reduction in ΔP is gained at the expense of a corresponding loss in steaming capacity.

There are in operation a number of locomotives in which the maximum cutoff is limited to a smaller proportion of the cylinder stroke than obtains in the normal locomotive. For instance, locomotive C has a maximum cutoff of 55 per cent of the stroke, and it is perfectly feasible to operate a locomotive at a maximum cutoff as low as 30 per cent. In such a locomotive, the economy in the use of steam, especially at the lower speeds, is such that boiler capacity may be reduced correspondingly.

In a locomotive with limited cutoff it is more important to reduce back pressure to the minimum than it is in a normal locomotive, since the back pressure bears a

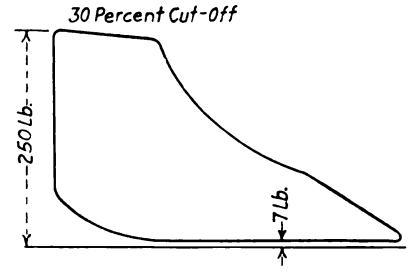


Fig. 26—Theoretical indicator card from locomotive with 30 per cent maximum cutoff

larger ratio to the mean effective pressure. In Fig. 26 is shown a typical indicator card from a locomotive having a maximum cutoff of 30 per cent. The back pressure is given as 7 lb., allowing a drop of 1 lb. between the cylinders and point A_1 of the cylinder exhaust passage, making $\Delta P = 6$. It is further assumed that the boiler, smokebox arrangement and nozzle are similar to those of locomotive A.

The problem is to determine the maximum weight of fuel which can be fired in unit time with the facilities available for moving the gases of combustion. It has been shown elsewhere [5] that the boiler efficiency of locomotive A is

$$F = 0.66 - 0.0876G \quad \text{.....(24)}$$

and the gas generated per pound of fuel fired is

$$W_f = (18 - 0.014G)\ (0.84 - 0.001047G) \quad \text{.....(25)}$$

It will be further assumed that $K = 13{,}500$ B.t.u per lb. Locomotive A is equipped with a type E superheater, a feedwater heater and carries a working pressure of 250 lb. per sq. in. Therefore, the heat supplied to the steam from the fuel $H_3 = 1{,}192$ B.t.u. per lb.

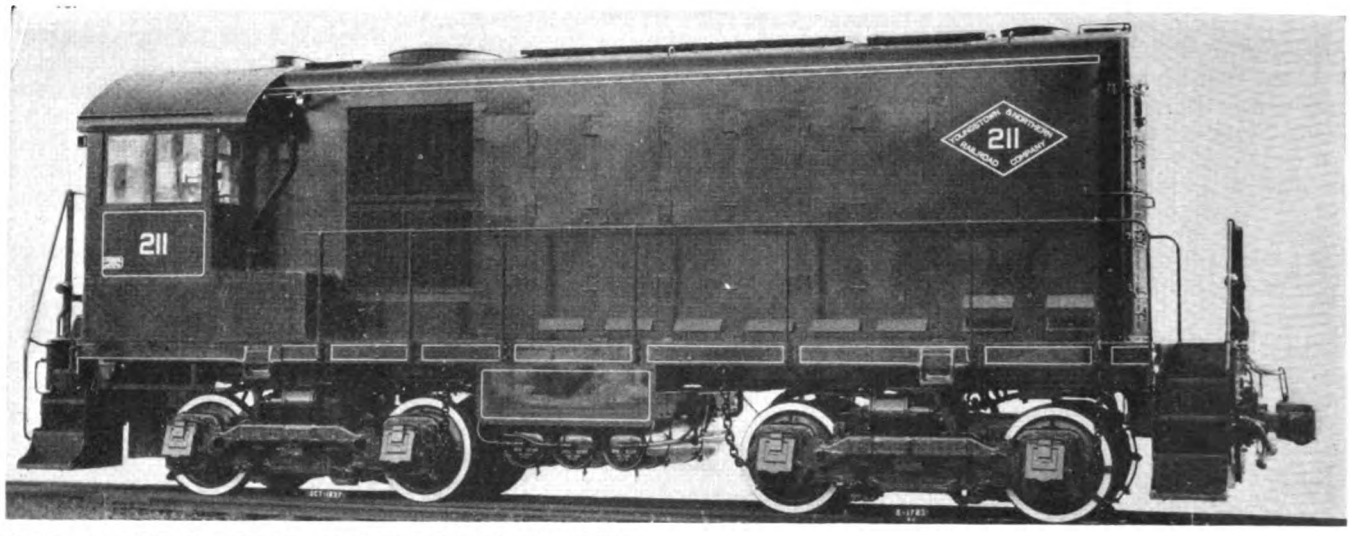
From Fig. 24 it will be found that the equation for A_2, when $\Delta P = 6$, is

$$A_2 = \frac{M_o - 2.76}{27.69} \quad \text{.....(26)}$$

and from Fig. 22 it will be seen that for locomotive A, at $\Delta P = 6$, the value of W_g is 24.10 lb. The steam diverted to the locomotive auxiliaries is approximately 7 per cent.

By this method it is necessary to assume a value for G, and by calculation prove its correctness. It will there-

(*Continued on page 97*)



Youngstown & Northern 900 hp. supercharged Diesel electric switcher

Youngstown & Northern 900 Hp.

Diesel Electric Switchers

Two 900 hp. units are designed with ample reserve capacity. The Diesel engines are of the Alco standard type, and are equipped with superchargers

IN October, 1937, the American Locomotive Company delivered two Diesel switchers to the Youngstown & Northern for transfer and heavy switching service. Each of these units contains one 900 hp. supercharged Alco Diesel engine. These locomotives are similar in design to one which has been in service on the South Buffalo Railway and the five in operation on the Birmingham Southern.

Mechanical Equipment

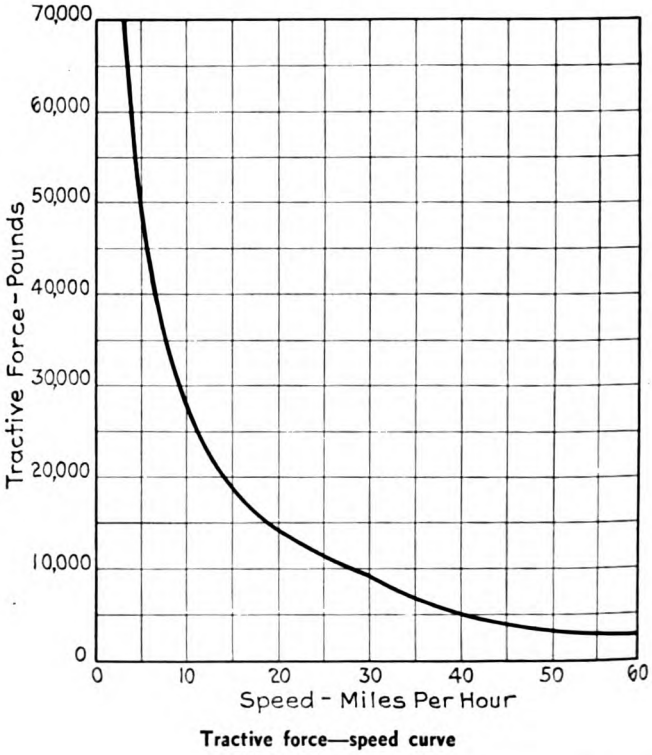
The operating cab is located at one end, while the hood construction is kept as narrow as possible, giving maximum visibility along the track. The underframe is constructed of heavy plate having the heavy center or backbone section especially designed for withstanding heavy shocks and collisions. The wide side steps on these locomotives are in accordance with standard practice on the steam switchers previously built by Alco for the Youngstown & Northern.

All operating details within the cab have been carefully laid out. The seats and arm rests are suitably upholstered. Side windows are suitably located for the engineman. The doors are of heavy steel plate. The control stand is conveniently arranged on the right side of the operator's cab.

The Diesel engine is started by pushing in a small button on the control stand which throws the current from a heavy-duty battery across the main generator, thereby electrically starting the engine. A feature in the operating cab is the use of electric heaters which give full output regardless of engine speed or temperature of cooling water. Sand boxes having ample capacity are provided both front and rear. The fuel tank is located

General Dimensions of the Youngstown & Northern Locomotives

Horsepower	900
Number of cylinders	6
Bore and stroke, in.	12½ x 13
Length overall, ft. and in.	43 - 11¾
Width overall, ft. and in.	10 - 0
Height from rail (max.), ft. and in.	14 - 9½
Wheel base, rigid, ft.	8 - 0
Wheel base, total ft. and in.	28 - 6
Truck Wheels, diameter, in.	40
Total weight locomotive, lb.	230,000
Weight on drivers, lb.	230,000
Starting tractive force, lb.	69,000
Cont. tractive force, lb.	30,000
Maximum speed, m.p.h.	60
Minimum radius curvature, locomotive alone, ft.	50



Tractive force—speed curve

underneath the operating cab and contains 500 gallons, which is ample for general operating conditions.

The power trucks, two in number, are of the four-wheel center-bearing type, having a special design of cast steel bolster. The axles are of open-hearth forged steel finished for truck and motor bearings, wheel and gear fits, and the journals are 8 in. by 14 in. The rolled-steel wheels are 40 in. in diameter. The brake rigging is all placed on the outside of the truck so that brake adjustments, inspection and brake-shoe renewals can be made with a minimum loss of time, and without going over a pit. The low side frames and absence of end frames allow ready accessibility to the inspection covers and oil reservoirs of the traction motors. The principal feature of this truck is that the construction provides for positive equalization at all times without the distortion of any truck members regardless of any uneven track condition.

Air-Brake Equipment

Two Westinghouse D-4-P air compressors are used to give a total of 100 cu. ft. per min. regardless of whether the Diesel engine is idling or operating at full speed. The air reservoirs are of exceptionally large capacity, containing 72,500 cu. in. Four air-brake cylinders, 12 in. by 10 in., are used. These cylinders are mounted on each side of each truck, taking care of equalization of braking entirely through air pipes. Automatic and straight-air brakes are used, operated through Schedule EL-14 equipment.

Electrical Equipment

These locomotives have ample reserve capacity. The four traction motors of the General Electric 726 type are especially suited to extra heavy duty service. The automatic control of the main generator is new though actually a modification of a proved design. It matches generator load to engine output at full engine speed through the entire range of locomotive speed. This feature eliminates the old differential control. The control was especially designed for the Alco 900-hp. Diesel locomotives. The generator is known as type GT-542.

An auxiliary generator delivering 125 volts at all engine speeds is used. This feature makes it possible to operate any one or all auxiliaries at full capacity at any time regardless of engine speed. The auxiliary generator, known as type GTB-542, is directly connected to the main generator which, in turn, is bolted to the Diesel engine, making the power plant one complete unit. The auxiliary generator furnishes current for the charging of the 56-cell heavy-duty starting battery, as well as the power to the air compressors, radiator fan motor, traction-motor blower motor, fuel booster pump and cab heaters.

The entire control of the locomotive is embodied in the operator's throttle which simply regulates the speed of the Diesel engine. Reversal is effected by a separate lever operating a master controller. The motors are operated in series at low speed and are automatically changed by a voltage relay to series parallel and again automatically changed to field shunt for high locomotive speeds.

Supercharged Diesel Engine

The Diesel engine used in these switchers is in effect the Alco standard six-cylinder 600-hp. engine supercharged to develop 900 hp. The bore and stroke is 12½ in. by 13 in. An interesting feature of this supercharged engine, as indicated by tests, is that it has no higher maximum pressures and actually lower exhaust temperatures than the same engine not supercharged. As far as the Diesel engine and supercharger are concerned these are the same as were used on the Birmingham Southern locomotives and were described in detail in the August, 1937, issue of *Railway Mechanical Engineer*.

Fundamentals Involved in

The Stopping of Trains*

By J. C. McCune†

A discussion of air-brake elements lying between the brake cylinder and the rail which limit or affect the retardation obtained when an application of the train brakes is made

In recent years, improvements in railroad practices have changed the underlying trend in air-brake development. It is no longer a matter of effecting changes so that the air-brake equipment *per se* will function more uniformly and satisfactorily, but of meeting requirements established by new demands for improved overall braking performance. To satisfy these demands, the entire braking system must be surveyed and the action of all elements co-ordinated so that the maximum efficiency may be obtained from the proper correlation of all the interdependent parts.

Specifically, this paper deals with those elements of the air-brake system which lie between the brake cylinder and the rail and which directly limit or affect the retardation obtained by an application of the brakes. These elements are the rail, the wheel, the brake shoes and the foundation brake rigging. Recent changes in railroad operating practices have emphasized the part these elements play in securing high rates of retardation. Without an understanding of the performance of these elements during braking action, and a realization of the limiting factors in obtaining improved performance, what can or can not be done with air brakes can not be clearly comprehended.

What stops a moving train when the brakes are applied? Essentially one thing, and that is the friction between the wheel and the rail. The amount of friction is determined by the resistance the wheel meets in its effort

* Abstract of a paper presented before the Southern and Southeastern Railway Club, at Atlanta, Ga., January 20, 1938.

† Mr. McCune is director of research of the Westinghouse Air Brake Company.

to revolve. Thus, when brake shoes under considerable pressure are applied to the wheels, the wheels revolve with difficulty and on this account, a very substantial friction exists between wheel and rail. This friction eventually arrests the motion of the train. Therefore, it is evident that the train is stopped, not directly by the brake-shoe friction, but by the very high friction the action of the brake shoes sets up between wheel and rail. This rail friction or retarding force is sometimes called adhesion, but in this paper, the designation "rail friction" will be employed. It should be kept in mind that, in discussing braking, rail friction is the same thing as retarding force.

Rail friction can attain high values before the wheel slides because it is static friction and not kinetic friction. Static friction is much greater than kinetic friction, especially when the velocities involved in kinetic friction are relatively great. From this it follows that all wheels under a train must continuously revolve if the stop is to be made in the shortest distance because then the rail friction or retarding force is greatest, since it is produced by static friction.

Although rail friction increases with the difficulty the wheel finds in revolving, it can not increase indefinitely. After the rail friction reaches a certain value, the wheel ceases to revolve and slides instead. The ratio of this limiting value to the weight on the rail is called the coefficient of adhesion. Thus, if the coefficient of adhesion is 25 per cent, the rail friction or retarding force can not exceed 25 per cent of the weight carried by the wheel. It should also be understood that this coefficient of adhesion must be applied to the wheel weight or pressure actually existing at the rail. This weight or pressure need not necessarily be the same with the car moving as with the car standing. For instance, during a stop, the car tends to overturn, with the result that weight is "transferred" from the trailing wheels to the leading wheels. Again, the wheel may oscillate due to the action of rail joints and for brief periods, the pressure on the rail may differ from the static weight. When the coefficient of adhesion is used to determine the maximum rail friction or retarding force, these variations from static wheel load must be kept in mind.

In braking trains, therefore, the coefficient of adhesion fixes the maximum retardation which can be employed. Stated in different words, it is the rail which limits the minimum stop distance, not the brake. It is obvious that if wheels are to revolve throughout the stop, the coefficient of adhesion must not be exceeded. It is advantageous in this connection to employ the term "per cent retardation" which may be defined as the ratio of the rail friction or retarding force to the weight actually carried by the wheels. This is the same ratio which is used to define the coefficient of adhesion but "per cent retardation" gives the ratio below the sliding point whereas the "coefficient of adhesion" gives the ratio at the sliding point. Thus, if the coefficient of adhesion is 25 per cent, any per cent retardation less than 25 could be used in braking a single car and there would be complete immunity from wheel sliding.

The Coefficient of Adhesion

Unfortunately, the coefficient of adhesion is by no means constant. Values for it have been reported by different experimenters ranging all the way from 8 per cent without sand on a poor rail to 40 per cent with sand on a good rail. For many years it has been considered in the air brake art that 25 per cent was attainable on the average rail, probably because this same value was employed in locomotive practice. Generally, the interest is in stop distances and not coefficients of adhesion, so that it seems worth while to examine what stop distances various coefficients of adhesion will permit.

The stop distance can be roughly determined when the retardation is known. This retardation is generally expressed in miles per hour per second. With 100 per cent retardation, the retarding force equals the weight carried by the wheel. A body decelerated by a retarding force equal to its own weight receives a retardation of 32.2 ft. per sec. per sec. But 32.2 ft. per sec. per sec. equals approximately 22 m. p. h. per sec. Thus, 100 per cent retardation means a retardation of 22 m. p. h. per sec. If 22 is multiplied by the per cent retardation expressed as a decimal, the result is the retardation in miles per hour per second.

From the foregoing, it is possible to calculate the stopping distances from 100 m. p. h. for different per cent retardations, such as given in the following table:

Retardation per cent	Retardation m.p.h. per sec.	Stops from 100 m.p.h. must exceed
10	2.2	3,333 ft.
15	3.3	2,222 ft.
20	4.4	1,666 ft.
25	5.5	1,333 ft.
30	6.6	1,111 ft.

It will be noted that it is said that the stopping distances must exceed the values given in the table. This is because the stopping distances are calculated on the assumption that the per cent retardation is instantaneously developed, is constant throughout the stop, and has the same value on every axle in the train. As none of these assumptions exist in actual practice, actual stops must always exceed these limiting stops and generally do so by a very substantial amount.

A sudden change of weather may necessitate a decreased brake effectiveness or longer stops. In the case of the rail, the conditions which prevail the greater part of the time provide a coefficient of adhesion of from, say, 20 to 25 per cent, which if *all other circumstances were ideal*, would permit a retardation of from 4.4 to 5.5 m. p. h. per sec. and a stop from 100 m. p. h. in from 1,333 to 1,666 ft. The more the braking system is improved, the nearer these ideal conditions will be approached.

The present era is one of speed and both passenger and freight trains are operating with higher schedule speeds than ever before. As a consequence, the stopping of these trains assumes a greater importance than it had in the recent past because of the higher speeds involved; therefore, to obtain short stops, it is necessary to apply a greater retarding force earlier in the stop. But this means that the danger of sliding wheels at the higher speeds is increased. The air brake must depend upon a high coefficient of adhesion or a good rail in order to obtain short stops, but if the rail happens to be poor, wheel sliding will result if an attempt is made to make these short stops. Up to date, the practice in the brake art has been to accept these occasional slides as the price of obtaining good stops under average conditions, but the rapid change in railroad operating methods may before long make this practice unacceptable.

Empty-and-Load Brakes

Much has been said by way of emphasizing that the rail determines the minimum length of stop. But the rail as the limiting factor has resulted in the development of a special air-brake equipment, namely, the empty-and-load brake. In the conventional single-capacity brake, the brake-shoe pressure in an emergency application is the same for the empty car as for the loaded car. Likewise the rail friction or retarding force does not change when the car is loaded. But it is clear that the retarding force per ton of weight to be braked does change radi-

cally. For instance, if the gross to tare ratio is 4 to 1, the empty car has four times the retarding force per ton that exists on the loaded car.

The necessity for empty-and-load brakes did not arise from any limitation within the air-actuated mechanism itself, but came instead because either rail adhesion or slack control prevented the use of one piston to operate the brakes on both the empty and the loaded car.

Practically, the need for empty-and-load brakes is less, the lower the gross to tare ratio. However, three factors have increased the gross to tare ratio for trains as a whole in recent years. First, the introduction of light-weight cars with a high gross to tare ratio; second, the withdrawal from service of older cars with a low gross to tare ratio; and, third, the intensive efforts to increase the average revenue load per car. All of these factors have reduced the effectiveness of the conventional single-capacity brake on loaded freight trains. However, the need for effectiveness has increased because loaded freight trains are now operated at speeds markedly higher than in the very recent past. The existence of these conditions amply justifies the Association of American Railroads in its recent action in specifying a minimum load braking ratio for new cars.

The Coefficient of Brake-Shoe Friction

It is generally recognized that a moving train represents a tremendous amount of kinetic energy, but it is difficult to visualize this energy so that it has a definite meaning. Perhaps, it can be better comprehended if the rate of doing braking work is expressed in terms of horsepower. When a brake dissipates 550 ft.-lb. of mechanical energy per sec. into heat, the brake is said to be dissipating 1 hp. It can be shown that the horsepower dissipated per ton, is the product of the retardation in m. p. h. per sec. and the speed in m. p. h. divided by 4.11. If a conventional axle with 30,000-lb. load were retarded at 4 m. p. h. per sec. 1,095 hp. would be dissipated at 75 m. p. h. It should, of course, be kept in mind that the instantaneous horsepower being dissipated decreases with the speed and becomes zero when the speed is zero.

Cast iron, for railroad service, appears the material best adapted to dissipating large quantities of heat and at the same time producing maximum friction with minimum wear. The brake-shoe friction is an actual force and is measured in pounds. However, it is more convenient ordinarily to refer, not to the friction itself, but to the ratio it bears to the pressure which produces it; that is, the coefficient of friction f which may be expressed either as a decimal or as a per cent. For illustration, if the coefficient of friction f is 10 per cent, the brake-shoe friction is 10 per cent of the pressure with which the brake shoe is pressed against the wheel.

From a braking viewpoint, it is highly desirable that f having a constant value, because the coefficient of adhesion, for a given rail condition, is the same at all speeds or at least does not appear to change to any marked extent. Therefore, the retarding force or rail friction, in emergency applications where short stops are desired, should remain constant. Since the rail friction is established by the brake-shoe friction, the brake-shoe friction should likewise be constant. The emergency cylinder pressure in the conventional brake is constant; therefore, the brake-shoe pressure is constant. If the ratio of friction to pressure or f did not change, obviously the retarding force would not vary. But unfortunately f does vary and in a manner poorly adapted to the requirements of the brake. This is because f decreases as the speed increases for all normal conditions where the heat dissipated is within the thermal capacity of the shoe. Consequently, for a constant cylinder pressure, the least retardation is secured at the higher speeds and the most at the lower speeds. To obtain short stops, the brake should be, if anything, most effective at the highest speeds because then so much distance is being rapidly covered. Since the reverse is true with cast-iron shoes, cast iron is not the ideal material for a brake shoe. How this has affected the development of brakes for high-speed trains will be mentioned later.

Not only does f decrease as the speed increases, but it also decreases as the pressure increases. When the brake-shoe pressure is increased, therefore, the friction obtained does not increase in the same proportion. Thus, if the pressure on the brake shoe is doubled, the friction is by no means doubled. The coefficient of friction for low shoe pressures is considerably greater than for high shoe pressures, the speed remaining constant. On this account, when a great deal of friction is wanted, it is obtained with difficulty, because the shoe pressure would have to increase, even if the coefficient of friction remained constant; as the coefficient actually decreases, a still further increase in pressure is called for.

It should be understood that f for a given speed and pressure does not always possess precisely the same value. This can be readily understood when it is considered that the friction is caused by intimate contact between shoe and wheel. The contact surfaces of both the shoe and the wheel change and as a result, f is not always the same for a given speed and pressure. This same variation in f, for what are apparently the same conditions, is found with all rubbing surfaces.

The Foundation Brake Rigging

The foundation brake rigging transmits and multiplies the force delivered by the brake cylinder in order to develop pressure on the brake shoes. Modern practice is to apply a brake-shoe pressure to the wheel which, nominally, is some two to three times the weight carried by the wheel. If a truck carried a load of 20 tons, this would mean nominal brake-shoe pressures of 40 to 60 tons; therefore, the parts of the brake rigging must be of large section and great strength.

It is obvious that these forces can not be transmitted with 100 per cent efficiency and that the actual pressure on the brake shoes is less than that indicated by multiplying the pressure on the brake piston by the leverage ratio. The ratio of the actual brake-shoe pressure to that which would be obtained if all the indicated pressure reached the brake shoes is called the rigging efficiency and for many years has been designated by e.

This matter of rigging efficiency is becoming of increasing importance because brake forces have been increased to meet the requirements of higher schedule speeds. The brake cylinder itself does not deliver all the force the piston receives from the pressure of the compressed air because of packing cup friction and resistance of the release spring. Perhaps 95 per cent would fairly measure the efficiency of the average cylinder. Then the efficiency of the pins, because of friction, is less than 100 per cent and decreases as the diameter of the pin increases.

The efficiency is further reduced because, with modern car construction and the increase in accessory equipment, it becomes increasingly impossible to employ the long rods, levers and hangers which provide the highest efficiency. It is not always recognized that friction reduces the efficiency of a short rod more than it does the efficiency of a long rod. Rubbing, binding, interferences of various sorts, and external release springs, obviously lower the rigging efficiency. In addition, the efficiency is further cut down by the angularity of various mem-

bers of the brake rigging. As a result of all these factors, the efficiency of the rigging is materially less than 100 per cent. About 25 years ago, the standing rigging efficiency of passenger clasp brakes was measured, in a few experiments, at from 60 to 85 per cent.

These experiments measured the efficiency between the brake cylinder and the brake beam. But the brake beam pressure is not directed toward the center of the wheel and it is this direct radial pressure which determines the amount of brake-shoe friction obtained. The determination of the direct radial pressure with the wheel revolving becomes a matter of considerable difficulty but generally the effect is to reduce the rigging efficiency further. Consequently, it appears that brake riggings are inherently not as efficient as generally they are considered to be.

It has long been the practice in the air-brake art to increase the force delivered by the brake cylinder so as to obtain the desired pressure on the brake shoes, irrespective of the rigging efficiency. It is becoming increasingly difficult to follow this practice in modern high-speed passenger braking because of the effect of these high forces upon the truck springs and the functioning of the truck. It is clear that the higher the rigging efficiency, the lower the braking forces transmitted from the brake cylinder need to be. On this account, very careful consideration of the brake rigging is justified.

Braking Ratio

Braking ratio expresses the ratio of the force on the brake-cylinder piston, multiplied by the leverage ratio of the rigging, to the weight being braked. What has been said about the efficiency of the brake rigging makes it evident that braking ratio is frequently employed in an improper sense.

Very generally it is thought that if two cars have the same braking ratio, they will be retarded at the same rate or will stop in the same distance from a given speed. This is not necessarily true. Braking ratio gives the pressure of the brake shoes, assuming 100 per cent efficiency, as a percentage of the weight being braked. But the efficiency is not 100 per cent and never has been. Because the efficiency of the brake rigging is not the same on all cars, the braking ratio should be multiplied by the rigging efficiency to obtain the actual pressure of the brake shoes on the wheels as a percentage of the weight braked.

Even the actual pressure of the brake shoes does not give the complete story. The coefficient of friction is not necessarily the same on all cars, if for no other reason than the difference in wheel loads and consequently in brake shoe loads, (since it has been pointed out that the coefficient changes with shoe load). Since the retarding force is the force to be considered and since this force is equal to the brake-shoe friction, recognition must be given to the friction actually obtained from a certain shoe pressure. But this is done by multiplying the actual shoe pressure by the coefficient of friction. Therefore, the braking ratio multiplied by the rigging efficiency and then by the coefficient of friction, gives a product which is the retarding force expressed as a percentage of the weight braked.

But this percentage has previously been defined as the "per cent retardation". If the possibilities of wheel sliding, the uniformity of braking on all axles, the rates of retardation and stop distances to be expected, and other questions of this character are to be examined, then knowledge of the per cent retardation is necessary. From all of this, it is evident that when entirely new conditions are confronted, braking ratio alone is not a sufficient indicator of what may be expected.

The Wheel

Under modern conditions, the wheel has been called upon to perform increased duty because, in many cases, not only has the load on the wheel been augmented, but also there has been a marked increase in the speed of operation. Much of the heat generated at the rubbing surfaces between brake shoes and wheels is lost by radiation. Since the speed is highest when the maximum heat is generated, the loss of heat to cooling currents of air is quite appreciable. Furthermore, a substantial amount of heat is carried away by the brake shoe dust, since the dust is heated to incandescence and forms sparks. Clearly the heat so obviously carried away by sparks does not pass into either the brake shoe or the wheel. However, it should be mentioned that the length of time the brake acts has a great deal to do with how much heat penetrates the wheel.

High-Speed Passenger Braking

Within the past few years, the schedule speed of passenger trains has been increased. In many cases, this has involved an increase in the maximum speed permitted. Emergency stopping distances vary with the square of the speed, all other conditions remaining the same, and assuming that (1) the brake reaches full effectiveness instantaneously and (2) the retarding force is constant throughout the stop; thus when the speed is doubled the stop distance increases four times.

In actual practice, the full effectiveness of the brake is not instantaneously developed and neither is the retarding force constant nor uniform throughout the stop. The air-brake equipment produces maximum cylinder pressure in a certain time which does not change with the speed of the train. This time becomes longer, moreover, as the number of cars in the train increase, and frequently an increase in train length has accompanied an increased schedule speed. On this account, stops from higher speeds tend to lengthen out of proportion, because of the time required to apply the brakes fully.

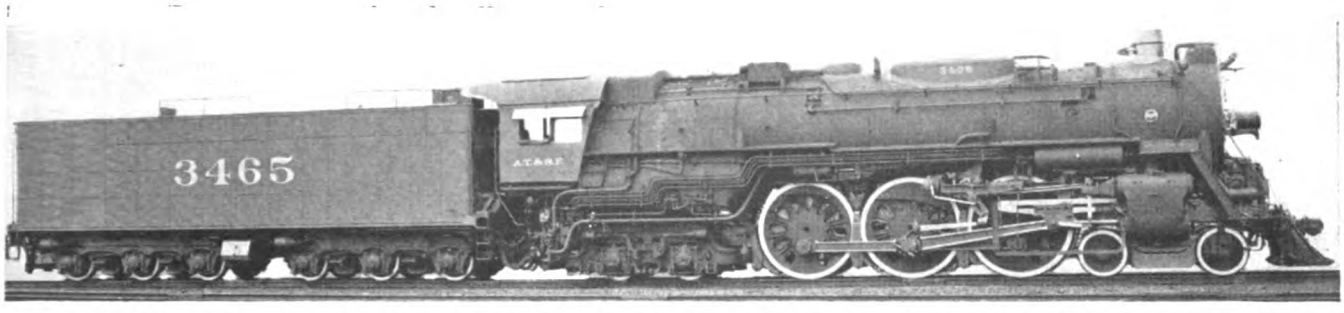
With conventional air-brake equipment, it has long been the practice to develop a certain pressure in the brake cylinder with an emergency application and to hold this pressure unchanged throughout an emergency stop. Evidently this means that the shoe pressure is substantially uniform throughout the stop. If the coefficient of friction did not change, a constant brake-shoe friction and hence a constant retarding force would be secured. But the coefficient of friction does change. It has already been pointed out that it decreases as the speed increases. Consequently, the minimum retarding force is obtained at the higher speeds. The stops from the higher speeds, therefore, tend to lengthen unduly.

The action needed to improve the stop distance is clear; that is, increase the brake-shoe pressure, and therefore the retarding force, at the higher speeds. But if this increased pressure is held undiminished throughout the stop, the retarding force will increase as the speed reduces and wheel sliding will be encountered at the lower speeds. The most modern brake equipments for high-speed service, therefore, are arranged to provide a variable cylinder pressure, so controlled that the desired retarding force is obtained at the higher speeds and yet wheel sliding is prevented at the lower speeds. Here again it will be noted that the air-brake equipment had to be changed, not because of any limitations within itself, but because of the demand for an improved overall braking performance.

From what has previously been said, it will be apparent that the brake-shoe pressures, or braking ratios, for these new high speed trains become quite high. Since

the coefficient of friction is low at high speeds, it is necessary to increase the shoe pressure to obtain the desired retarding force. But this increase in shoe pressure itself lowers the coefficient of friction. Consequently, a further increase in pressure is called for. This higher pressure means larger brake pins, and space limitations necessitate shortening the various members of the brake rigging, both of which tend to reduce the rigging efficiency. On this account, the cylinder force or the leverage ratio must be increased. The net result of this chain of influences is that very high braking ratios are employed in the most modern practice. As illustration, a few high-speed trains have arrangements for the use of 300 per cent braking ratio.

In conclusion, the foregoing presentation has discussed some of the fundamentals involved in braking but it should be understood that in actual practice, many other factors must be considered which are not here touched upon. The problem, as a prominent railway executive has put it, is an engineering one of the first magnitude. When attention is given to the fact that the modern brake may be called upon to dissipate, as an instantaneous maximum, well on to 2,000 hp. per axle, it is evident that the engineering problems encountered are many and difficult. These problems are constantly under scientific investigation and, with cooperation among the railroads and the manufacturers, there is every reason to believe that results can be produced which will be satisfactory.



Santa Fe passenger locomotives with 84-in. drivers, 23½-in. by 29½ cylinders and 300 lb. boiler pressure, develop 49,300 lb. tractive force.

Santa Fe High-Speed

Passenger Locomotives

Baldwin delivers six high-capacity 4-6-4 type locomotives with 84-in. driving wheels, one of which is streamline — For use on eastern lines

SIX high-speed passenger locomotives of the 4-6-4 type have recently been delivered to the Atchison, Topeka & Sante Fe by the Baldwin Locomotive Works. One of these locomotives is streamlined. All are equipped for oil burning and are for service on the 992 miles of main line from La Junta, Colo., east to Chicago. The weight on drivers is 213,440 lb. and the total engine weight 412,380 lb. The driving wheels are 84 in. in diameter and the locomotives develop a tractive force of 49,300 lb., with a boiler pressure of 300 lb. per sq. in. The combined heating surface is 6,850 sq. ft. and the grate area (area inside the mud ring) 98.5 sq. ft.

The outstanding features of these locomotives are the use of special materials and structural features in the boiler to adapt them to the high steam pressure; the large diameter of the driving wheels, the bed casting, the unique engine-truck design and the fuel-oil tank, which is built into the water tank in such a way as to permit conversion to coal-burning with a minimum of structural change.

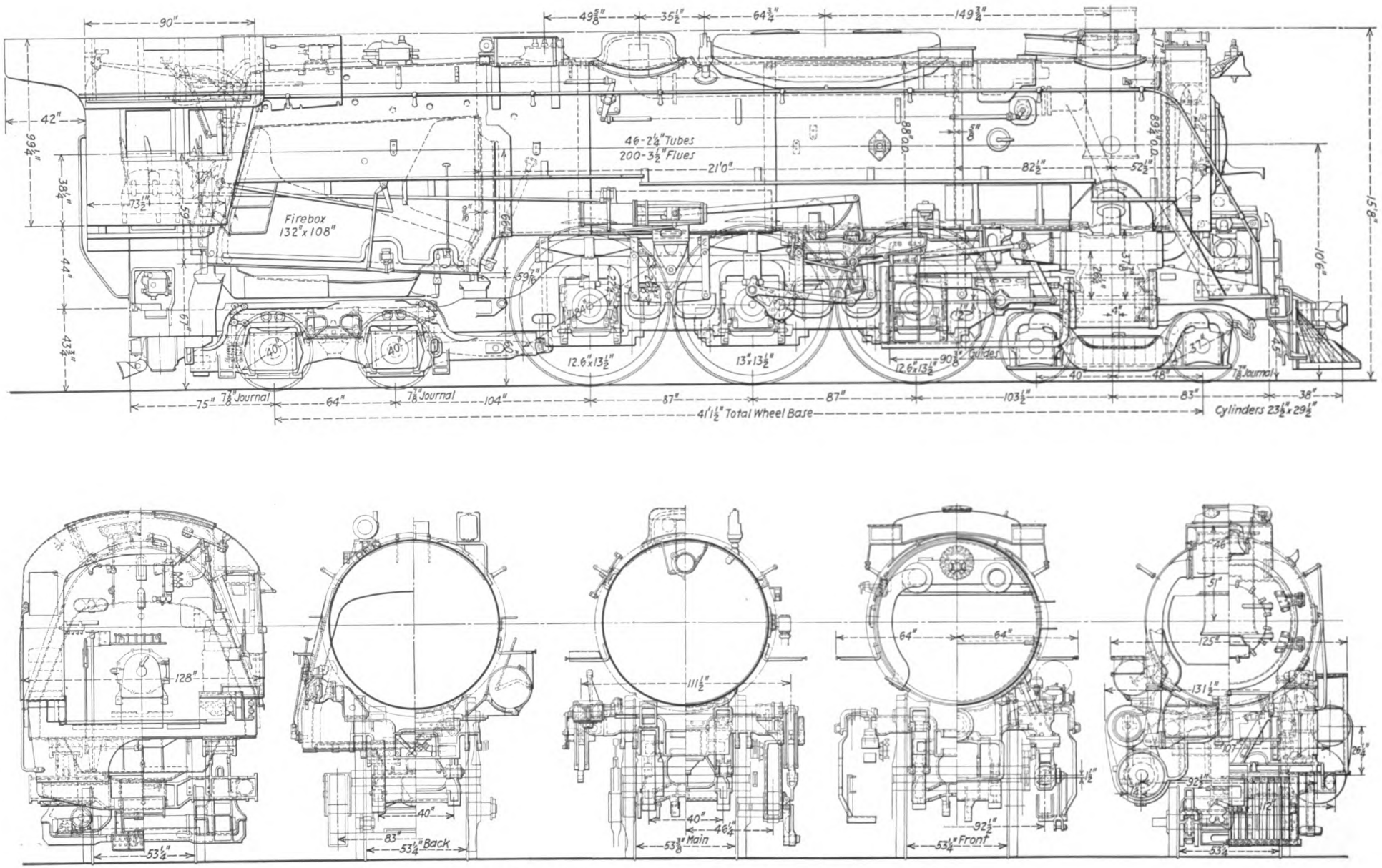
The Boiler

In point of boiler proportions these locomotives exceed any of the 4-6-4 type which have yet been built. They are first in total evaporative heating surface, superheating surface and grate area. With the exception of the Lord Baltimore of the Baltimore & Ohio, they also carry the highest boiler pressure of any existing locomotive of this type and their working pressure has not been exceeded by any locomotive boiler built with the staybolt type of firebox.

The boiler shell courses and outside firebox sheets are of nickel steel on all of the locomotives and in the case of the streamline locomotive a nickel firebox steel has been used for the inside firebox sheets. The boiler seam rivets are also of nickel steel.

The first shell ring is 88 in. in outside diameter. The plate in this and the second ring is $^{27}/_{37}$ in. thick and that in the third ring, which is 91-$^{7}/_{16}$ in. in outside diameter, is $^{7}/_{8}$ in. thick. The roof sheets are $^{13}/_{16}$ in. thick, the back head $^{1}/_{2}$ in., and the side sheets $^{7}/_{16}$ in. thick. The inside crown and side sheet and the door sheet are $^{13}/_{32}$ in., the back tube sheet $^{9}/_{16}$ in. and the front tube sheet $^{5}/_{8}$ in.

The firebox is of unusual width. It is 108 in. inside the side sheets and 132 in. in length, and the crown and side sheets are in one piece. There is no combustion chamber. Although not horizontal, the rear of the mud ring is only 7 in. higher than the front. The side water legs of the firebox are vertical for 18 in. above the bottom of the mud ring and the back door sheet is perpendicular 12 in. from the mud ring to facilitate the application of firebrick lining above the cast-steel draft pan. With the exception of the four rows on each side



Cross-section and elevation of the Santa Fe 4-6-4 passenger locomotives

at the break of the crown sheet and at the syphon flanges, which have solid heads, F. B. C. adjustable crown stays are installed. F. B. C. flexible bolts are also installed in the breaking zone and are hollow drilled for electric testing.

All longitudinal shell seams are seal welded for distances varying from 9 to 14 in. at the ends. The mud ring seams for the flue sheet, door sheet, back head, and throat sheet are seal welded for their entire length, and the calking edges between the door and side sheets are welded for a distance of 36 in. up from the bottom. The door flanges in the back head and door sheet are joined by a butt weld. The waist-sheet angles are not riveted to the boiler pads.

The boiler has a main and an auxiliary dome. The main dome is of cast steel and is solid, without cover. The opening in the auxiliary dome is large enough to permit a man to enter the boiler and on this dome cover are mounted the safety valves.

The boiler is laid out for an Elesco Type E superheater with 101 units, and the American multiple throttle is built into the header. The feedwater heater is the Worthington Type 6Sa. The heater unit is mounted in the top of the smokebox in front of the stack, the hot-water pump on the engine bed under the smokebox and the cold-water pump on the left side of the locomotive near the tender. Other equipment on the boilers includes the Signal Foam-Meter and Electromatic blow-off cock arrangement. The draft pan is fitted with a 3½-in. Booth burner.

The locomotives are fitted with box type spark arresters which are completely closed at the top, sides and bottom. The bottom rests directly on the exhaust pipe and the stack extension extends down through the top. The sides are curved parallel to the smokebox shell. The front of the arrester is open. A portion of the rear is completely closed with a large rectangular panel of double louvers, those at the rear running diagonally and those within the spark-arrester shell running vertically. The stack has a hinged extension top operated by a pneumatically actuated rack and pinion. The smokebox door ring is fitted with Okadee hinges.

Principal Dimensions, Weights and Proportions of the Sante Fe 4-6-4 Type Locomotives

Railroad	A. T. & S. F.
Road Class	3460
Road numbers	3460-3465 (1 streamline)
Date built	1937
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	15-8
Height to center of boiler, ft. and in.	10-6
Width overall, in.	131½
Cylinder centers, in.	92½
Weights in working order, lb.:	
On drivers	213,440
On front truck	83,950
On trailing truck	114,990
Total engine	412,380
Tender	396,340
Wheel bases, ft. and in.:	
Driving	14-6
Rigid	14-6
Engine, total	41-1½
Engine and tender, total	88-8
Wheels, diameter outside tires, in.:	
Driving	84
Front truck	37
Trailing truck	40
Engine:	
Cylinders, number, diam. and stroke, in.:	2-23½×29½
Valve gear, type	Walschaert
Valves, piston type, size in.	13
Maximum travel, in.	7
Steam lap, in.	1⅛
Exhaust clearance, in.	⅛
Lead, in.	5/16
Cut-off in full gear, per cent	86½
Boiler:	
Type	Straight Top
Steam pressure, lb. per sq. in.	300
Diameter, first ring, inside, in.	86 5/16
Diameter, largest, outside, in.	91 7/16
Firebox, length, in.	132
Firebox, width, in.	108
Height mud ring to crown sheet, back, in.	72
Height mud ring to crown sheet, front, in.	83 11/32
Thermic syphons, number	2
Tubes, number and diameter, in.	46-2¼
Flues, number and diameter, in.	200-3½
Length over tube sheets, ft. and in.	21-0
Net gas area through tubes and flues, sq. ft.	9.71
Fuel	Oil
Grate area, sq. ft.	98.5
Heating surfaces, sq. ft.:	
Firebox	280
Thermic syphons	95
Firebox, total	375
Tubes and flues	4,395
Evaporative, total	4,770
Superheating	2,080
Combined evap. and superheat.	6,850
Feedwater heater, type	Worthington
Tender:	
Style or type	Water bottom
Water capacity, gal.	20,000
Fuel capacity, gal.	7,000
Trucks	6-wheel
Rated tractive force, engine, lb.	49,300
Weight proportions:	
Weight on drivers ÷ weight, engine, per cent	51.75
Weight on drivers ÷ tractive force	4.33
Weight of engine ÷ comb. heat. surface	60.2
Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	5.47
Tube-flue heat. surface, per cent comb. heat. surface	64.16
Superheat. surface, per cent comb. heat. surface	30.37
Firebox heat. surface ÷ grate area	3.81
Tube-flue heat. surface ÷ grate area	44.63
Superheat. surface ÷ grate area	21.18
Comb. heat. surface ÷ grate area	69.62
Gas area, tubes-flues ÷ grate area	.099
Tractive force ÷ grate area	500.50
Tractive force ÷ comb. heat. surface	7.20
Tractive force x dia. drivers ÷ comb. heat. surface	604.50

The Engine Bed and Running Gear

The foundation of the locomotive is a bed casting with which the cylinders and back cylinder heads are integral. The casting also includes brackets or pads from which are supported the air pumps, hot-water pump, cold-water pump, the waist sheets, guides, valve gear and brake cylinders. Provision has also been included for the support of the stoker conveyor and grate shaker cylinders should occasion arise to convert the locomotives to coal-burning in the future. The front furnace bearer supports are also cast integral with the bed, as is also the attachment for the expansion-plate support at the rear end of the firebox. The main reservoirs are not included in the bed and the front bumper is a separate casting.

The driving wheels are Baldwin disc type cast-steel centers with the main wheels cross-counterbalanced. The journals are fitted with SKF roller-bearing boxes with 13-in. by 13½-in. journals on the main axle and 12.6-in. by 13½-in. journals on the front and rear axles. All driving boxes have ⅛-in. lateral play in the pedestals. The driving axles, as well as those on the engine-truck, trailer truck and tender trucks are carbon steel. The driving axles are hollow bored.

The front trucks on these locomotives have inside journal bearings and are of the Batz four-wheel design. This is an equalized type of unusual construction. The equalizer on each side of the truck is of the double type, both sides of which are cast integral with a spring pocket long enough to take eight single coil springs. Above the springs is a long cast-steel cap of inverted channel section which is located directly under the side member of the truck frame. The frame is carried directly by the spring cap on a rocker pin located on the transverse center line of the truck. Each equalizer terminates in a circular pad at each end which bears on a rocking plate in the top of the journal box. The clearance between the top of the spring cap and the underside of the truck side frame provides a limited freedom of movement of the equalizer.

The bolster is carried on constant lateral resistance rockers which are supported directly from the transoms of the truck frame. The truck has an initial lateral re-

sistance of 40 per cent and a constant resistance of 33½ per cent. The center plate in the top of the bolster is lined and bushed with phosphor bronze and is lubricated. The engine and truck center plates are locked together by a 4-in. split-type center pin.

The journals are 7-⅞ in. in diameter and are fitted with SKF pedestal type roller-bearing boxes. The boxes have 1/16 in. lateral play in the pedestals. The wheels are 37-in. in diameter.

The trailer truck is a four-wheel Delta type, all wheels being 40 in. in diameter. The outside journals are fitted with SKF roller-bearing boxes of the same journal diameter as those of the front truck. On the front axle the boxes have ⅛ in. and on the rear axle, 5/16 in. lateral in the pedestals.

The main driving springs have reverse camber. The front hanger is solidly connected to the bed casting, while the hanger at the rear of the trailer truck is connected through a double-coil snubber spring.

The main and side rods are of chrome-nickel-molybdenum steel with floating bushings at the back end of the main rod and both ends of the main connection side rod. Pressed bushings are used in the front side rods. The front end of the front side rod is set with 1/16 in. lateral on the crank pin. The main crank pin is of nickel-chrome steel hollow bored to 3½ in. diameter, the cavity being used as a grease cup. The front and rear pins are of carbon steel.

The piston heads are of special heat-treated alloy cast steel, with the Locomotive Finished Material combined Universal sectional type bull rings and packing rings of bronze and are carried on 4½-in. quenched and tempered carbon-steel piston rods. The cross-heads and guides are of the Laird type, the latter fitted with the Slid-Guide attachment. T-Z packing is applied on the piston rods and valve stems.

The reciprocating parts on each side of this locomotive weigh 1,805 lb., of which 38.8 per cent is balanced. At 84 m.p.h. (diametral speed) the theoretical dynamic augment is 9,457 lb. per wheel in the front and rear pairs and 14,186 lb. per wheel in the main pair of drivers.

The valve motion is of the Walschaert type which drives 13-in. valves with a maximum travel of 7 in. The valves have one-piece bronze bull rings and packing rings. The link blocks are faced with phosphor-bronze bearing metal, deposited by electric welding. The reverse gear is the Baldwin type C.

Lubrication

Each locomotive is equipped with three force-feed lubricators. A Nathan type DV-7 36-pint lubricator with eight feeds and eight four-way distributors supplies oil to the pedestal faces of the engine truck, driving wheels and trailer truck. One distributor provides two feeds for each main guide. With the exception of the streamline locomotive, two Chicago 40-pint lubricators, one on each side, feed oil to the cylinders and valves. An extra feed on the left side lubricates the hot-water feed pump. The cylinder and valve lubrication on the streamline locomotive is provided by two Nathan DV-7 lubricators.

Alemite fittings are provided on all rod cups on the crosshead pins and on the eccentric crank pin. The flange oilers are the Swanson type.

Partial List of Materials and Equipment on the A. T. & S. F. 4-6-4 Type Locomotives

Paint	(s) E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Bed casting	General Steel Castings Corp., Eddystone, Pa.
Boiler and firebox steel	Lukens Steel Co., Coatesville, Pa.
Staybolt iron	Ewald Iron Co., Louisville, Ky.
Flexible and radial staybolts	Flannery Bolt Co., Bridgeville, Pa.
Boiler braces	Ewald Iron Co., Louisville, Ky.
Rivets:	
Firebox	Burden Iron Co., Troy, N. Y.
Mud ring, back head and boiler seam	The Champion Rivet Co., Cleveland, Ohio
Smokebox door ring hinges	The Okadee Company, Chicago
Draft pan	General Steel Castings Corp., Eddystone, Pa.
Boiler lagging	(s) Johns-Manville Sales Corp., New York (3) United States Gypsum Co., Chicago (2) Standard Asbestos Mfg. & Insulating Co., Kansas City, Mo.
Steam-pipe covering	Union Asbestos & Rubber Co., Chicago
Nicholson Thermic syphon	Locomotive Fire Box Co., Chicago
Feedwater heater	Worthington Pump and Machinery Corp., Harrison, N. J.
Elesco Type E superheater	The Superheater Company, New York
Multiple throttle	American Throttle Co., New York
Steam and air gages	Ashton Valve Co., Boston, Mass.
Blow-off cocks	Crane Co., Chicago
Washout plugs	Huron Mfg. Co., Detroit, Mich.
Cab seats	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Steam heat equipment; flexible metallic conduit at rear of tender	Vapor Car Heating Co., Inc., Chicago
Radial buffer and Unit Safety drawbar	Franklin Railway Supply Co., Inc., New York
Injectors	(s) Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn. (5) Ohio Injector Co., Wadsworth, Ohio
Safety valves	Coale Muffler & Safety Valve Co., Baltimore, Md.
Signal Foam-Meter and Electromatic blow-off cock	Dearborn Chemical Company, Chicago
Sanders	(s) Viloco Railway Equipment Co., Chicago (5) Graham-White Sander Corp., Roanoke, Va.
Speed recorder	Weston Electrical Instrument Corp., Newark, N. J.
Bell ringer	Viloco Railway Equipment Co., Chicago
Headlights	The Pyle-National Co., Chicago
Turbo generator, Type SD-B	(s) Sunbeam Electric Mfg. Co., Evansville, Ind.
Main and side-rod forgings	A. Finkl & Sons Co., Chicago
Piston rods	Standard Steel Works Co., Burnham, Pa.
Piston heads and piston-head packing rings and universal sectional type bull rings	Locomotive Finished Material Co., Atchison, Kan.
Piston-rod and valve-stem packing, Diamond type	T-Z Railway Equipment Co., Chicago
Cylinder cocks	The Okadee Company, Chicago
Reverse gear, Type C	The Baldwin Locomotive Works, Philadelphia, Pa.
Engine truck (Batz) castings	General Steel Castings Corp., Eddystone, Pa.
Trailer truck, four-wheel Delta type	General Steel Castings Corp., Eddystone, Pa.
Driving wheels, disc type	The Baldwin Locomotive Works, Philadelphia, Pa.
Driving tires	Standard Steel Works Co., Burnham, Pa.
Driving boxes, roller bearing	SKF Industries, Philadelphia, Pa.
Trailer wheels	Standard Steel Works Co., Burnham, Pa.
Roller bearings, trailer truck	SKF Industries, Philadelphia, Pa.
Springs	American Steel Foundries, Chicago
Front bumper beam	General Steel Castings Corp., Eddystone, Pa.
Rod bushing and other bearing metals	Magnus Metal Div. National Lead Co., New York
Unit cylinder clasp brakes	American Steel Foundries, Chicago
Air brakes, No. 8ET	Westinghouse Air Brake Co., Wilmerding, Pa.
Train control	Union Switch & Signal Co., Swissvale, Pa.
Lubricators	Nathan Manufacturing Co., New York Ohio Injector Co., Wadsworth, Ohio
Rod-cup fittings, eccentric-rod and crank fittings, cross-head-pin fittings	Alemite Div. Stewart-Warner Corp., Chicago
Engine coupler	National Malleable and Steel Castings Co., Cleveland, Ohio
Flexible joints on steam-heat line (between engine and tender)	Barco Manufacturing Co., Chicago
Tenders:	
One-piece water-bottom casting	General Steel Castings Corp., Eddystone, Pa.
Tank steel	Lukens Steel Co., Coatesville, Pa.
Trucks, Pullman six-wheel type	General Steel Castings Corp., Eddystone, Pa.
Wheels and axles	Standard Steel Works Co., Burnham, Pa.
Springs	American Steel Foundries, Chicago
Roller bearings	SKF Industries, Philadelphia, Pa.
Coupler, Type E, and draft gear	National Malleable and Steel Castings Co., Cleveland, Ohio

NOTE: (s) Streamline locomotive.

These locomotives have No. 8ET Westinghouse air brakes with brake shoes on the drivers, trailing truck and tender. The braking ratios are 75 per cent on the drivers and 47 per cent on the trailer. The single 8½-in. cross-compound air compressor is mounted above the front deck of the bed casting at one side. The train-control equipment is the Union Switch & Signal Company's three-speed continuous type. Except for the streamline locomotives these engines are equipped with Pyle-National 1,000-watt, 32-volt turbo generators with dynamotors on the train-control equipment boxes. The streamline locomotive is fitted with a Sunbeam turbo generator with a dual-voltage generator.

The turret is mounted under a housing in front of the cab. Saturated steam is supplied through two 3½-in. extra-heavy pipes extending back from the dome to the turret; one pipe on each side, outside the boiler shell. Weston speed recorders are applied on all of the locomotives. The Unit Safety drawbar and Franklin type E2 radial buffer are applied between engine and tender.

The Tenders

The tender underframe is the General Steel Castings water-bottom type. This is arranged for the application of a submerged stoker trough and stoker engine in the left water leg should the locomotives subsequently be converted to coal burning.

The oil tank is integral with the water-tank structure. Conversion for coal can be made by removing the top of the oil tank over the coal space and substituting coal gates for the front oil-tank closure. Shapes and plates in the water and oil tanks are copper-bearing steel.

The six-wheel tender trucks are of the Pullman type, the castings for which were furnished by the General Steel Castings Corporation. The elliptic bolster springs are of chrome-vanadium steel. The rolled-steel wheels are 37 in. in diameter and are mounted on SKF roller-bearing axles. The tender trucks are fitted with Simplex unit cylinder clasp brakes.

The Streamline Locomotive

The streamline locomotive is covered with a light steel shrouding which is designed to blend into the contour of the train. The boiler shroud ends in a bullet nose at the front and the skirting below the running board covers the cylinders but does not cover the driving wheels and running gear. The sides of the cabs are fitted with removable sections to provide access to stay-bolts and there are doors in the boiler shrouding where needed for access to the equipment mounted on the boiler.

The shrouding is painted in two shades of blue with the under portion of the locomotive and tender, including the running gear, in black. An 18-in. stainless-steel strip, on which the words "Santa Fe" and the number "3460" are sand etched and filled in with black, extends from the front end of the locomotive to the rear of the tender on each side at running-board level. Other striping is in silver lead and the faces of the driving-wheel tires and hubs are finished with aluminum paint, as are also the tires of the engine- and tender-truck wheels. The handrails are of stainless steel. The handrail columns, cab handles and other exposed fittings are chromium plates. Rods and motion work are highly polished. The principal dimensions, weights and proportions of these locomotives are shown in the table.

The Locomotive Front End

(*Continued from page 87*)

fore be assumed that $G = 104$ lb. Therefore, we have

$$M_o = \frac{(R_o\ G\ FK)\ 0.93}{3600 \times H_3} \qquad (27)$$

$$= \frac{70 \times 104 \times 0.0569 \times 13500 \times 0.93}{3600 \times 1192} = 12.12 \text{ lb.}$$

$$A_2 = \frac{12.12 - 2.76}{27.69} = 0.338 \text{ sq. ft.}$$

$$W_f = \frac{24.1 \times \sqrt[3]{0.338 \times 3600}}{\sqrt[3]{0.321 \times 70 \times 104}} = 12.12 \text{ lb.} \qquad (28)$$

and, applying equation (25)

$$W_f = [18 - (0.014 \times 104)]\ [0.84 - (0.001047 \times 104)] = 12.10$$

Since the value of W_f as found by equations (25) and (28) is substantially the same, we must conclude that the maximum weight of fuel which can be fired per square foot of grate area per hour under the given conditions is 104 lb., and the steam available for the cylinders is 43,600 lb. per hr. This example illustrates the uses to which Figs. 22 and 24 may be applied.

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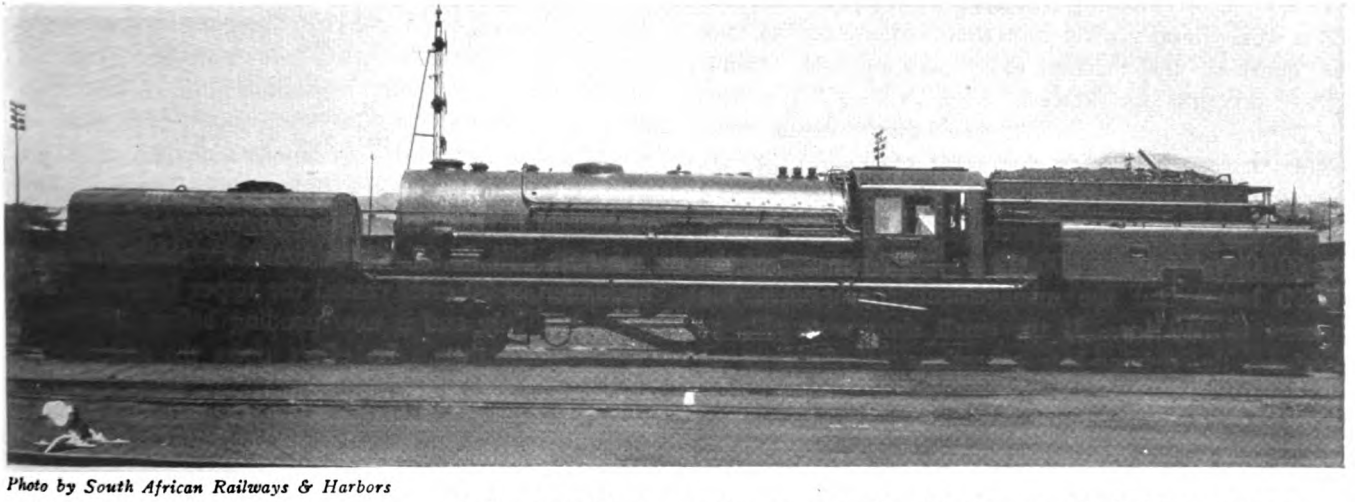


Photo by South African Railways & Harbors

This Garratt articulated locomotive represents the heaviest type of motive power on the 3-ft. 6-in. gage South African Railways

EDITORIALS

Does the Small Shop Need Good Tools?

Two circumstances combine to make life difficult for the man who has to operate the small railroad repair shop—the fact that it is usually located on a road which has limited appropriations and the fact that, not having any large-quantity-production problems to solve, those who are responsible for expenditures seem to "let him get along with what he has." The result is, in all too many cases, that the small shop finds it more difficult to do the work that must be done at a cost within the ability of the management to pay. The principal reason is that the margin between the permissible expenditure for labor and the actual cost of doing the work is usually so narrow that a slight change in conditions may seriously affect the ultimate result.

An analysis of the machine-tool problem of the small shop provides some exceedingly interesting facts. Take for example, the case of a shop recently studied where the appropriation for classified repairs allowed an average expenditure of about $4,200 for labor for each of less than 20 locomotives that would pass through the shop for repairs. That portion of the appropriation for labor that could be allocated to the machine shop for the entire year would buy, at the old wage rate, 9,120 machine-operator hours. Under the new, increased, wage rates the number of machine-operator hours that the appropriation would pay for is reduced to 8,590—530 less hours in the machine shop in which to do the year's work. Assuming that there is just as much work to be done, how are the 530 hours to be made up?

To carry this hypothetical analysis a bit farther, let's take the job of repairing driving boxes. First, we find, upon studying the analysis of operations that in a well-equipped shop somewhat larger than the one in question, the machine-tool operations on driving boxes accounts for between seven and eight per cent of the machine-hours for the entire shop. In the small shop we are discussing the total machine time per average box handled is about 400 minutes and for the 150 boxes handled in an average year the total would be 60,000 minutes, or 1,000 hours—11.7 per cent of the 8,590 hours that the management appropriated the money to pay for. If the small shop were able to perform the driving-box operations as efficiently as the somewhat larger shop mentioned above, in which the box machining time was between seven and eight per cent, it could have saved $325 on labor on the box job alone. An actual comparison, operation for operation, shows that the small shop requires 400 minutes of machining time to do a job that the larger shop does in 175 minutes.

The machine-tool problem of the small shop is not one of determining how to obtain maximum production on a quantity of parts. Therefore advantage can not usually be taken of specialized machines and tooling equipment. The job in the small shop requires that the few machines the installation of which can be justified shall be of a type and capacity that will assure the most efficient production on the great variety of work which must, of necessity, be put on them.

In any shop, large or small, a thorough analysis of the work to be done is vitally important. In the small shop such an analysis may disclose the fact that the difference between operating within appropriations and not doing so may lie in the decision to scrap two or three obsolete machines and replace them with modern equipment. Where the margin is so narrow failure to make the right decision may cost money which the management hasn't got. The small shop needs good tools.

The Train Limit Bill

For many years it has been the policy of the train-service brotherhoods to advocate legislation the effect of which is to increase the number of train-service employees required for the movement of a given volume of traffic. While such legislation has been proposed and advocated on the grounds that it is necessary for the removal of hazards to life and limb from railway operation, the consistency with which an increase in employment has been the most immediate and important effect has created a strong presumption that such, in fact, has been their main purpose. This applies to the eight-hour legislation, the various full-crew laws which have been advocated and some of them passed by state legislation and the train-limit legislation which has likewise been proposed in various states and is now pending in Congress.

Senate Bill S. 69, which limits freight trains to a maximum of 70 cars, passed the upper house of Congress last July and is now pending before the House of Representatives. Its effect upon the railroads is estimated, on the basis of 1936 traffic, to increase the freight-train miles in the United States by sixty million and the railways estimate an addition to operating expenses in excess of one hundred million dollars per year.

Usually when make-work legislation has been under consideration in the past, the safety claims of the proponents have not been subjected to critical analysis with clear-cut factual results. In the case of the present proposed train-limit legislation, however, such is not the case. L. K. Sillcox, vice-president, New York Air Brake Company, has made an exhaustive analysis of the records of railway accidents during the year 1936. In a paper presented before the gradual School of Business Administration at Harvard University on February 16, he discloses some of the results of his research. He classifies accidents in four groups according to the nature of their causes. There are casual accidents which, like those in any industry, increase with the number of employees and which will, therefore, be increased by any condition causing more trains to be operated for the movement of a given volume of traffic. Such accidents occur in boarding and alighting from trains; slipping and falling on cars or on the ground ; in the regular performance of duty, etc. Boiler explosions and accidents in connection with the servicing of locomotives at terminals likewise increase with the number of locomotives required in the performance of a specific service. The second classification includes those causes unaffected by the size of train or manner of its handling, such as the failure of a rail beneath a train, causing derailment, or falling in connection with setting out cars at industrial sidings. The third classification includes shock accidents due to slack action, the situation with respect to which Mr. Sillcox points out has been improved by the present standards for draft gears and draft-gear maintenance and are being improved by the gradual installation of the AB brake. A fourth classification covers accidents resulting from misinterpretation of visual signals between the head and rear end of the train. The latter two are those in which the length of the train may be a factor.

Taking these classifications in order, there were 2,107 deaths in casual accidents which may be expected to increase with the number of employees, of which 1,273 were trespassers, 696 non-trespassers (mostly occupants of automobiles or pedestrians killed at grade crossings) and 138 employees. Of the 704 in the second group—those unaffected by the size of the train —620 were trespassers, four were non-trespassers and 80 were employees. In the case of the accidents caused by internal train shock, 20 were trespassers, none were non-trespassers and 12 were employees. No deaths were reported as due to misinterpretation of visual signals.

This analysis clearly indicates that any increase in the number of trains resulting from enforced limitation in the size of trains will cause far more deaths than will be saved, assuming that all of the 20 trespassers and 12 employees who lost their lives in accidents caused by internal train shocks were engaged in handling trains longer, rather than shorter, than 70 cars. Mr. Sillcox points out, however, that, but six of the 32 deaths of persons involved in fatal shock accidents (two of whom were railway trainmen) were caused on trains of over 70 cars. Furthermore, grade-crossing accidents, with 50 killed or permanently injured and 112 less seriously injured, were caused by trains of 70 cars or less, and but 45 of such accidents, with 20 killed or permanently injured and 42 injured, but not permanently, were caused by trains of 71 cars or more.

In the face of these facts, which clearly indicate the preponderant effect of the number of trains in determining the total list of annual deaths from railway operation, how can safety longer be claimed any justification for train-limit legislation?

Machinery Obsolescence Exacts Its Toll

The lamentable thing about obsolete railway machine tools and shop equipment is that it exacts its full toll of reduced production, regardless of whether management cannot or will not scrap it in favor of more modern equipment. In other words, when replacement funds are not available, railroads almost invariably have to pay, through increased repair costs and loss of serviceability of rolling stock, more than the purchase price of necessary new machinery which is not theirs even after they have spent the money.

Shop machinery depreciation reserves, designed to take care of wear alone, are far from adequate, judging from figures just released by the I. C. C. Bureau of Statistics, which show that in 1936 Class I carriers, exclusive of switching and terminal companies, spent slightly over $15,000,000 for shop machinery repairs whereas only $463,000 was set aside for machinery depreciation. The total investment in railway machinery is not exactly known but the depreciation rate is in all probability not over three per cent which assumes a service life of 33 1/3 years. True, shop machinery can be kept operating, from a mechanical standpoint, for even longer than that, *providing the manufacturers have not gone out of business and repair parts of that vintage are still obtainable.* Generally speaking, however, the cost of maintaining these old machines is excessive and represents a definite drain on the railway treasury, a fact well substantiated by the shop machinery repair bill for 1936.

Entirely aside from wear depreciation, there is the important factor of obsolescence. Since railway shops and enginehouses are not operated on a commercial basis and compelled to "shut up shop" when they fail to meet competitors' quality standards and prices, the mechanical-department officers, including shop managements, all too often seem to overlook or disregard obsolescence and its insidious hidden costs. They certainly have not the instinct or vision of the late Andrew Carnegie, who, in the classic example so often quoted,

scrapped 1½ million dollars worth of equipment in a new rail-rolling mill before it was ever used, simply because of a revolutionary improvement which came along and rendered it obsolete.

Mr. Carnegie could not afford to keep out-moded equipment in service, even when in the best of physical condition—and neither can the railroads. It is an unfortunate fact that railroads have to pay for obsolescence in shop machinery and tools even when they don't buy new ones.

The Trend in Calculating Air-Resistance Forces

During the developmental stages of engineering projects, one usually has to contend with diverse opinions advanced by different investigators and supported by a wealth of complicated mathematics—this has been true of the investigations undertaken to determine the power savings effected by streamlining railroad motive power and rolling stock. However, in this instance, it is noteworthy that in 1934, the American Locomotive Company, the American Car and Foundry Company, and the J. G. Brill Company combined their resources and efforts in promoting wind-tunnel tests of models at New York University, under the direction of Professor A. Klemin. The results of these tests were used to develop formulas for calculating the air resistance of full-size equipment, but as is often the case the formulas were quite complicated and so formidable that, in most cases, only engineers directly involved in design of streamline equipment were interested. Therefore, the simplification of these formulas became desirable. This has been accomplished by A. I. Lipetz, consulting engineer in charge of research of the American Locomotive Company, and his simplified formulas, with proof of their validity, were published in the October, 1937, issue of the A. S. M. E. Transactions.

The simplifying of the formulas reduces the complicated forms to a more usable basis, and although the aerodynamic engineer may criticize the method of reduction, the fact remains that simplified forms serve very well for estimating air resistance. The formulas recommended by Mr. Lipetz for calculating the air resistance of streamline locomotives and trains hauled by streamline locomotives, as well as the air resistance of standard equipment, all appear in keeping with experimental data and should be extremely useful.

Some engineers do not look with favor on the streamlining of steam locomotives because the streamline shroud increases the initial cost of the locomotive, it is not effective at common operating speeds, and makes maintenance more difficult due to decreased accessibility of locomotive parts. They also advance the argument that if the added weight of the shrouds were expended in developing a more powerful locomotive, the locomotive would have increased availability. However, these criticisms are not usually made to the streamlining of equipment propelled by internal-combustion engines. Regardless of such criticism, when engineers are given the opportunity of studying power saving effected by streamlining, which is made easier by the formulas developed by Mr. Lipetz, the advantages of streamlining become more and more obvious, especially since the tendency is undoubtedly toward higher scheduled speeds with still higher sustained speeds where track conditions are suitable.

Obviously, the gains to be obtained in reducing air resistance by application of streamline shrouds depends on the streamline design. The streamlining of locomotives in this country has been criticised abroad because some of it has been done with little or no regard for gains to be effected by reducing air resistance, which criticism on the basis of streamlining effectiveness is justified. However, such criticism is invalidated when one considers that the term "streamlining" is often applied for the want of a better word, such as "stream-styling," which implies that appearance of the locomotive has been changed to conform to a vogue of modern fashion—a change which admittedly has caught the public's fancy.

"Stream-styling" is undoubtedly but one step toward streamlining. There is no reason to doubt that complete streamlining cannot be accomplished with style, as evidenced by some of the power built in this country and abroad in recent years. Therefore, the aerodynamic problems being solved today by eminent research engineers through formulas readily usable by all engineers, regardless of their training and experience, is a step forward toward making streamlining and "stream-styling" synonymous. It is in this regard that we should appreciate the streamline-model tests of the American Locomotive Company, American Car and Foundry Company and J. G. Brill Company, and the expanding of the results to full-size equipment by means of simplified and usable formulas, as accomplished by Mr. Lipetz.

New Books

MODERN LOCOMOTIVES OF THE L. M. S. *By D. S. Barrie. Published by The Locomotive Publishing Co., Ltd., 3 Amen Corner, London, E. C. 4. 34 pages, 8½ in. by 5½ in., illustrated. Paper bound. Price, 30 cents.*

"Modern Locomotives of the L. M. S." reviews the history of locomotives of the London Midland & Scottish Railway from just prior to the amalgamation of the 130 or more British railways into four large groups under the Railway Act of 1921. It describes the development of many types of locomotives and gives details concerning numerous types, including the latest 4-6-2 streamline Coronation engine.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Labor's Attitude

I presume what is uppermost in many mechanical peoples' minds today is the attitude of labor towards the management; in other words, the effort for organized labor to dominate shop policies to such an extent as to increase costs and decrease efficiency.

Plain Common Sense

An after dinner speaker recently said that the social and economic status of a man could be gaged by the frequency with which he changed his shirts—varying, say, from one a week to several each day. Bruce Barton, a member of Congress from New York City, put it in a more homely way in his recent message to the New York Railroad Club on the occasion of its sixty-fifth anniversary dinner. "Certainly," said Mr. Barton, "when an industry, which provides the best rail freight service in the world at the lowest average rates in the world, finds nearly 100 of its constituent companies and 28.1 per cent of its total mileage in the hands of receivers or trustees, it is time to 'Stop, Look and Listen.' Sound governmental regulation of transportation must, of course, continue. I believe that government must remain on top of such situations. It must make the rules, but at least the players are entitled to their board and an occasional change of socks and underwear."

Broaden Your Knowledge of Railroading

You speak of properly educating the public, which is a most essential undertaking. Before that can be done, however, the railroad man himself must be educated. Far too many officials, as well as employees, are completely absorbed in the routine details of daily work in their own circumscribed field, and show little or no curiosity concerning the basic principles underlying the daily routine. Many a man looks on his own particular department as the bright center of the railroad universe, without ever bothering to acquire even a smattering of knowledge regarding other departments, which might enable him to carry on a fairly intelligent discussion of current problems. While I am fully aware that railroading is a complicated business of many aspects, so that no one person can possibly be a complete master of the art, I still believe that the average railroad man would be a better salesman for the industry he represents, if he had a considerably wider knowledge of that industry.

The Foreman and Safety

We all have workmen who are not safety-minded. They may be slow thinkers, or are careless with their tools and shiftless with their personal belongings. Every foot of floor space in his department should be thoroughly checked by the foreman; everything should be cleaned up, materials and tools put in their proper places, the floors swept and a generally neat appearance maintained. Let the men know that you will not tolerate slipshod methods and that cleanliness must exist throughout your department. Just because things are cleaned up and in order, don't imagine you can forget safety even for a moment. The alert foreman should make frequent routine inspections, so that he may be assured at all times that he has done everything possible to prevent hazards of any kind. You may be criticized and it may even be intimated that you care more for a polished floor than you do for output. You will find, however, that your output will increase, with a better standard of work, and that your department will be free from costly accidents. If a foreman lets down in his part of accident prevention, the men will follow suit.

Proper Training for Apprentices

One of the most important problems today in the mechanical department is the proper training for apprentices. I feel that it should be given a lot of consideration. It is my belief that the more training that can be given an apprentice, the more benefit will be derived from this class of employee. When a young man is taken into a shop to learn the trade, he should be taken on probation for a given period of time. If it is found that he does not apply himself, he should be dropped from the service, since it is not treating the young man or the corporation right to allow him to continue at something he is not trying to improve himself in. There are many shops where boys are taken in to learn a trade and they just drift along for four years, after which they are supposed to be skilled mechanics, but are not, because of not getting the proper instruction during their course of apprenticeship. It is money well spent by any company to pay someone to look after the apprentices and organize them in classes to see that they take the proper interest in their work and get instructions that will enable them to fit themselves to become skilled workmen. The companies that are having someone follow up these young men and see that they get the right sort of training are the ones that are getting the best results. By so training these young men you are fitting them to handle the work ably and they will become assets to the company rather than a liability.

Most Useful Tool in Boiler Shop

What is the most economical and useful tool in the boiler department today? Some twenty-five years ago the problem was to keep diamond points, chisels, sets and rippers in usable condition, whether they were being used in the field or at the shop. In the field the common practice was to carry a large supply of such tools with many hammer handles. In the shop the difficulty was broken tools, with the everlasting cry of low air pressure—not losing sight of the fact that many eyes were lost, because goggles were not worn or were worn on the forehead. Today this condition, whether it be in the field or at the shop, has changed with the use of the oxyacetylene cutting blow-pipe. The unit consists of a supply of gases and a blow-pipe; this replaces the former equipment which consisted of diamond points, chisels, sets and much hard work and grief, at the same time doing the work in some five per cent of the former time. These facts make the oxyacetylene equipment almost indispensable in the boiler department of today. Many of our shops have oxyacetylene piped through a dual pipe line system, with outlets located at the most advantageous points. When a cutting operation is required it is only necessary to connect the equipment to these outlets and proceed with the work. For these reasons the most economical and useful tool in the boiler department today is the oxyacetylene cutting blow-pipe.

IN THE BACK SHOP AND ENGINEHOUSE

Building Up of Driving-Box Hub Liners*

By Irving T. Bennett†

Locomotive driving-box hub liners in some instances have been a source of trouble and expense to many railroads. It is more or less standard practice to cast standard bearing bronzes on the hub face of the driving boxes, depending upon dovetails, insert pins and other mechanical means for the proper fastening of the liner. Such methods produce a mechanical joint of uncertain value, particularly due to the fact that the bronzes employed, for the most part, possessed high shrinkage values. Moreover, the particular alloys used, while possessing good antifrictional properties, lack malleability and have poor resistance to pounding or impact loads.

The combination of a poor mechanical fit, together with the inherent lack of ductility very often results in service failures. It is not uncommon to require liner replacement several times between classified repairs, because the liners work loose, crack and fall out. Replacements are expensive, not only in labor and material but, furthermore, cause a hidden expense of considerable magnitude, depending upon the time the locomotive is out of service due often to this condition.

A careful study of the problem indicated the need for the liner to be securely fastened to the face of the box and also pointed toward the necessity of employing a metal of high physical values more suited to resisting shock and wear. It was natural, therefore, to consider the use of welding to affix the liner permanently to the surface of the steel box.

Table I — Physical Properties of Herculoy and Other Bearing Metals

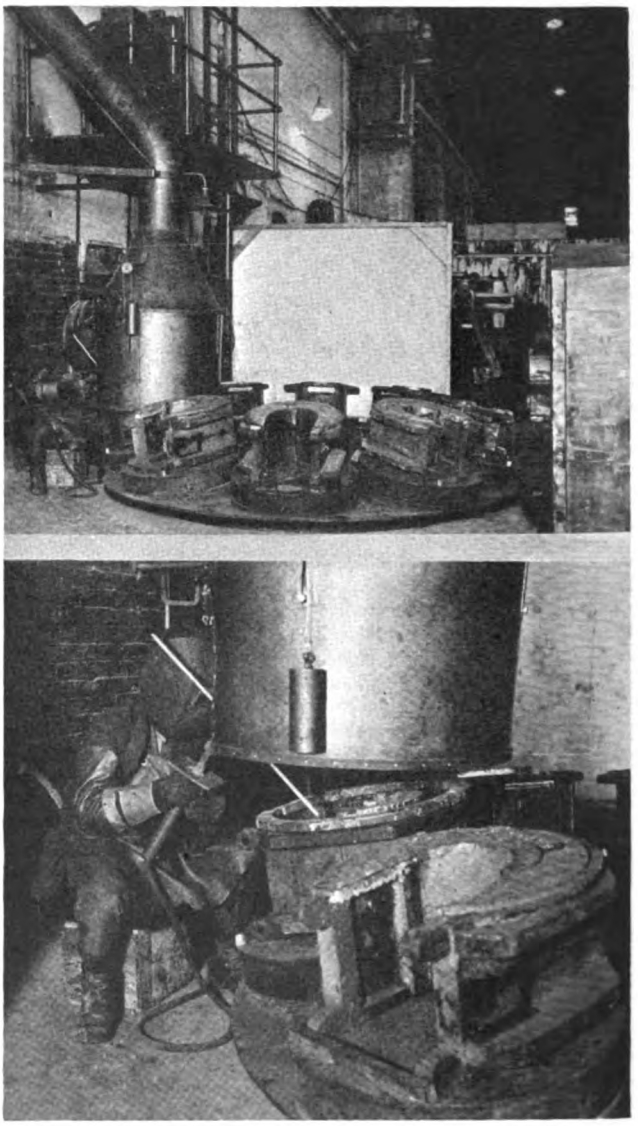
	Condition	Rockwell Hardness, C scale	Ult. tensile strength lb. per sq. in	Elongation, per cent in 2 in.	Impact Izod, ft.-lb.
Herculoy	Soft rod	91	63,000	72.0	...
	Drawn rod	105	72,000	50.0	...
	Cast	90	51,500	70.0	55.0
Leaded Herculoy	Cast	83	46,800	56.0	15.0
10-per-cent phosphor bronze	Cast	90	51,700	18.0	3.5
10-per-cent phosphor bronze leaded	Cast	85	45,900	16.0	3.5
Cu-Sn-Pb (80-10-10)	Cast	83	39,600	9.5	3.0
Cu-Sn-Zn (88-10-2)	Cast	90	44,300	10.0	7.5

Through the courtesy and assistance of the New York Central System, a test program was planned. One set of tests called for building up the entire face of the box by means of the electric arc, employing materials later described. A second test consisted of placing a plate of rolled metal on the face of the box and suitably welding it in place. A third series consisted of placing suitably designed segments of rolled material welded to the surface of the box on their edges and to each other. In undertaking this experimental program, several alloys were carefully investigated, the physical properties determined and a study made of the weldability of these alloys, coupled with an estimation of their wearing properties, particularly after deposition by the electric arc.

Table I shows the physical properties of the metals considered. The ease of weldability, high physical strength and high resistance to impact, led to the selection of Herculoy, an improved silicon-copper alloy of the following analysis: Copper, 96 per cent; silicon, 3.50 per cent; and tin, 0.50 per cent. Silicon is very efficacious in improving physical characteristics, its effect being several times that of tin. For purposes of comparison, test bars were made from cast material, as this was essentially in the cast condition. It will be noted that the Herculoy possessed the best combination of high physical properties and hardness with high impact values.

Test Results

It was expected that any of the methods employed would result in a liner which would remain permanently attached to the surface of the box, possess good wearing properties, extend service mileage and eliminate entirely the need of repair or replacement at the frequent inter-



Top: Set-up at the West Albany shops of the New York Central System for welding driving-box hub liners—Driving boxes are on turntable with a ventilating hood at the left—Bottom: Driving boxes in position for welding

* Abstract of a paper presented at the 18th annual meeting of the American Welding Society, Atlantic City, N. J., Oct. 18-22.

† Revere Copper & Brass, Incorporated.

vals previously encountered when the old cast method was employed. The results of these tests were very positive in character and Table II indicates the wear found on the various boxes after 114,202 miles of service operation, which mileage on this particular railroad is that usually encountered between classified repairs.

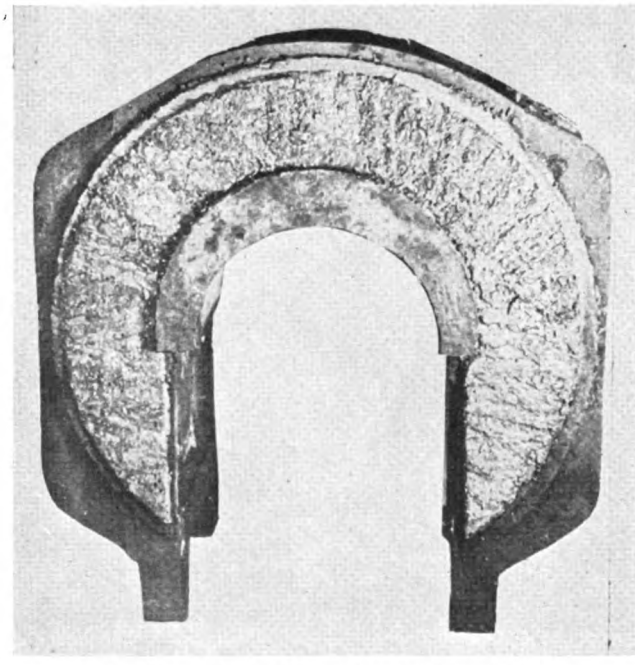
It will be noted that the boxes built up entirely by means of the electric arc performed as well as the boxes on which the plates and segments were used. The use of the electric arc provided a very flexible and versatile method of accommodating all sizes and shapes of boxes with a minimum amount of inventory and, consequently, it was decided that this method was best adapted to the solution of the particular problem. Further tests pro-



Partially welded box viewed over the welder's shoulder—Backing ring, crown brass and asbestos dams in place

vided satisfactory checks and, as a consequence, the New York Central System adopted this practice as standard.

Further metallurgical developments were made whereby substantial amounts of lead were included in the deposited metal. Lead, present as such, materially improves the machinability of the deposits and, further, aids the antifrictional properties of the alloy. It was



Arc-deposited hub liner before finish machining

containing as high as 15 per cent or more of free lead, although in commercial application the lead content is less than this. The use of the electric arc, particularly the metallic arc, results in very uniform dispersion of the lead throughout the alloy; in fact, the uniformity is better than that commonly found in cast material.

Certain machining tests were conducted on driving boxes in which surface speed as high as 265 ft. per min. were used, which value is considerably in excess of normal machining requirements on a job of this character.

In an application of this kind, welding speed, coupled with well-bonded metal, was of paramount importance. One of the novelties of this work lies in the fact that metallic electrodes up to 5/8 in. diameter have been employed, although 1/2 in. diameter is most commonly used,

Table II — Performance of Herculoy for Hub Faces on Locomotive Driving Boxes

Three methods were decided upon:
1—Building up the face of the box by fusing Herculoy rod with the electric arc.
2—A solid liner plate of Herculoy welded to the box face.
3—A series of segments of Herculoy welded to the box face.

The above three methods were tried on the driving boxes of a J-1 type locomotive. Periodic check-ups were made during the regular quarterly inspection periods, and final inspection was made when this locomotive was unwheeled and made ready for shopping. The mileage was 114,202 miles. The following tabulation is self-explanatory:

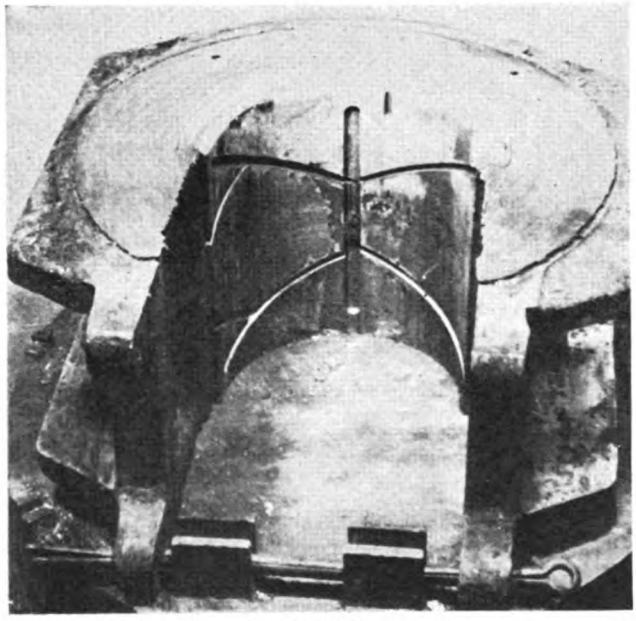
Designation of Driving Box	Front R-1	Front L-1	Main R-2	Main L-2	Rear R-3	Rear L-3
Form	Rod-arc built all-way	Rod-arc built all way	Solid plate welded on	Solid plate welded on	Segments welded on	Segments welded on
Measurement from jaw face to box face, in.:						
Original	2 19/32	2 19/32	2 21/32	2 21/32	2 19/32	2 19/32
Final	2 19/32	2 9/16	(See Notes)	2 19/32	2 9/16	2 19/32
Liner wear at point above jaws, in.	0	1/32	...	1/16	3/32	0
Approximate liner wear at top of hub face, in.	1/8	1/8	...	7/32	1/16	5/32
General appearance of liner face	Excellent	Excellent	...	Excellent	Excellent	2 Segments missing

NOTES:
General appearance of wheel hubs:
In every case, hubs were unmarked, bright and shiny; no evidence of cutting or galling.
The main box, right side, was taken out of service November 26, 1934, due to hot crown brass.
The rear box, left side, lost two segments. On this box segments were welded on edges only.

CONCLUSIONS:
1—From tests, observation and service, it is felt that Herculoy is ideally suited to application for locomotive hub liners.
2—It is possible to expect service from such liners from "shopping" to "shopping."
3—The rod method seems best adapted to this problem, although segments are satisfactory if welded on edges and middle.
4—Economies of considerable magnitude may be expected because of continued operation, also to the fact that but little work is necessary to resurface.

previously considered impractical to permit lead to be present in a welding rod, and in fact, all manufacturers' specifications very stringently covered this point by holding permissible lead in welding and brazing rods to only a trace. By the development of a proper welding technique, it was found possible to arc deposit alloys except on the Baltimore & Ohio, where 3/8-in. coiled rod is employed.

Experience has proved that the best procedure for applying Herculoy is with the metallic arc, using reverse polarity. Table III shows recommended practice. The metallic arc is more fool proof, in the hands of inex-



Typical welded hub liner after 115,000 miles of service returned for rewelding—Note the entire liner is present and wear is uniform

perienced operators, than the carbon arc. It is true that larger amounts of metal can be melted down with the carbon arc, but it requires proper technique and training to insure a proper bond of the metal so deposited. The bond with the metallic arc is inherent with the process. When using either process, suitable electrode

Table III — Recommended Practice for Welding with Herculoy

Rod size, in.	Metallic-arc current value, amp.	(Reverse polarity) closed circuit, volts
3/8	450	30-35
1/2	600	30-35
5/8	750	30-35
	Carbon arc	
	Carbon size, in. / Current, amp.	(Direct polarity) volts
3/8	5/8 / 450	40-45
1/2	3/4 / 600	40-45
5/8	1 / 750	40-45

holders must be employed and the operator protected with suitable clothing. Provision should also be made for the removal of welding fumes, since the large current values cause some volatilization of the metal.

Study was made covering the effect of varying rate of deposition on the character of the deposited metal, the efficiency of the deposition, spatter losses incurred and other pertinent factors. Tables IV and V show certain of the data developed. In conducting the deposition-rate studies shown, considerable difficulty was experienced in getting results that would be consistent as to the time and rate of deposition when using the carbon arc, whereas with the metallic arc, it was possible to duplicate the results very closely from test to test. The operation of the carbon arc depends greatly upon the operator's technique, and, if a firm bond is made to the underlying steel, the time required is about the same as when using the metallic arc. If it is just a question of seeing how much rod can be melted, the time is very much decreased by the use of the carbon arc, all of which is clearly shown on the tabulation.

Effect of Welding on the Driving Box

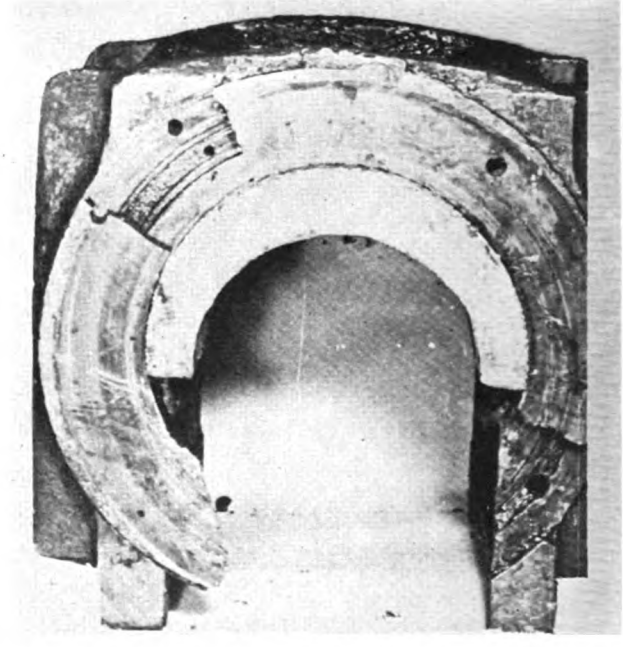
Some apprehension was felt by certain engineers regarding the structural changes taking place in the cast-steel surface of the box during a welding operation proceeding at high speed and with high current values. A box was prepared in the normal method and, after deposition, cut transversely into a number of sections which were carefully polished and checked for cracks and structural changes in the steel. Furthermore, analyses were made at various intervals to show the distribution of the silicon through the deposited metal, as well as to determine the extent to which iron migration occurred during the welding operation.

A detailed study of the steel surfaces disclosed no sign of cracks. There is a continuous gradation of temperature away from the bond, which produces a consequent gradation of grain sizes in the affected zone. Original structure is found about $3/16$ in. from the bond. The photomicrographs show representative structures, but not the entire area of change.

Molten steel migrates into the deposit while it is molten and varies from near 10 per cent at the bond to 1 per cent 1 in. from the bond. The steel is fairly evenly distributed, as shown by micrographs and chemical analyses. The silicon content of the deposit is not effected to any great extent by the welding process.

The Baltimore & Ohio Methods

This article will give only a brief outline of the work actually done at certain railroad shops. The General Electric Company, in cooperation with the Baltimore &



Typical cast hub-liner failure—Note how the left portion of the liner has slipped around after cracking, and that the right-hand tip is missing

Ohio, developed an automatic arc welding head, using a 3/8-in. electrode in coil form. This automatic head is attached to a fixture similar to a small radial drill with a swing arm around the vertical column, which provides a horizontal adjustment and may be used by the operator to start his weld either from the inside or outside diameter of the box surface. The deposit may be as much or as little as desired, depending upon the regulation of the equipment. Under the swinging arm and adjacent to the column, the driving box is positioned upon a rotating table properly regulated to time itself with the feed of the electrode through the automatic head. In dealing with new boxes, the surface is suitably sand-blasted, following which the Herculoy is de-

posited to any required dimension. It is reported that a new box can be built to full liner dimensions in approximately 1 hr. Boxes previously arc welded and requiring only one layer to compensate for lateral wear are welded in approximately 20 to 30 min. It is stated that mileage obtained before requiring lateral repairs

Table IV — Lead-Coated Herculoy Fusion Rods Time Studies

Diameter of rod, in.	Amp.	Volts	Electrodes used on 1-hr. operation, lb.	Comments
½	450	30	34.4	Good appearance
	550	35	45.0	Good appearance
	700	35	53.0	Good, but too hot
	800	40	62.0	Fair—too hot

Actual time to completely weld a J-1 driving box (dovetailed type):

Rod, in.	Amperes	Volts	Actual time	Amount of metal used, lb.
½	550	35	78 min.	46.5
½	700	35	55 min.	40.0
⅝	800	35	65 min.	51.0

On one of the complete boxes, a machine cut of ¼ in. was taken, and then it was resurfaced in one pass, using ½-in. by 24-in. rod at 600 amp., 35 volts. Actual time was 15 min., and weight of rod used was 9 lb.

ranges as high as 120,000 to 150,000 miles, a great deal, of course, depending on the class of service and the territory in which the locomotive is performing.

The New York Central Method

The New York Central apply material by means of the metallic arc manually operated. An interesting and effective method of handling boxes was developed by their engineers. Eight boxes are mounted on a revolving turntable, so the welding operation is practically continuous. While the welder is at work, his helper can unload previous boxes and mount the ones to be welded. Each box on the turntable can also be rotated and is

Table V — Deposition Rate Study of Lead-Coated Herculoy Rods

Process	Rod Diameter	Amp.	Volts	Lb. rod per hr. Used	Lb. rod per hr. Deposited	Per cent spatter loss	Lb. dep. per kw. hr.
Metallic arc..	⅜	380	30	28.49	27.79	2.43	2.44
		450	30	35.76	34.17	4.17	2.53
		500	30	38.72	36.72	5.16	2.45
Metallic arc..	½	500	30	43.10	41.30	4.17	2.75
		600	30	46.69	44.39	4.92	2.47
		700	33	54.99	50.57	8.04	2.19
Metallic arc..	⅝	700	33	62.46	57.78	7.50	2.50
		800	35	66.00	57.60	12.72	2.06
Carbon arc...	½	500*	42	47.96	47.96	0	2.28
		500†	42	97.68	97.46	0.20	4.64
		600*	42	65.25	65.25	0	2.59
		600†	42	128.13	127.84	0.20	5.08
		700*	45	139.04	138.72	0.20	4.40
Carbon arc...	⅝	700†	45	156.47	156.03	0.30	4.95

* Metal fused to base to insure good bond.
† Metal simply melted down in carbon flame and puddled.

mounted at an incline of 10 deg. with the horizontal. This permits "up-hill" welding, which is quite essential, due to the large current values employed, and permits the arc to work on new surfaces by preventing the mass of molten metal running ahead of the point of contact.

A counterbalance is provided for the rod holder and an exhaust applied over the box being welded.

A copper-faced steel ring is very successfully used to dam the edges of the box.

Rods are ½ in. diameter and are deposited using a current value of 650 amp. Old boxes with the dovetail naturally require more material than the new boxes. Speed of the operation is such that the old boxes are built to the proper dimension in approximately one hour's welding time. New boxes, requiring less metal, are built to proper liner thickness in approximately 40 min., whereas boxes coming in for resurfacing are usually welded in 20 to 30 min.

The original performance expectations on this railroad have been borne out, and it is practically unknown at this time to pull a locomotive out of service between classified repairs on account of undue lateral wear or hub-liner failure.

The welding supervisor of the West Albany shops of the New York Central System gave certain cost data before the New England Railway Club, which is repeated here:

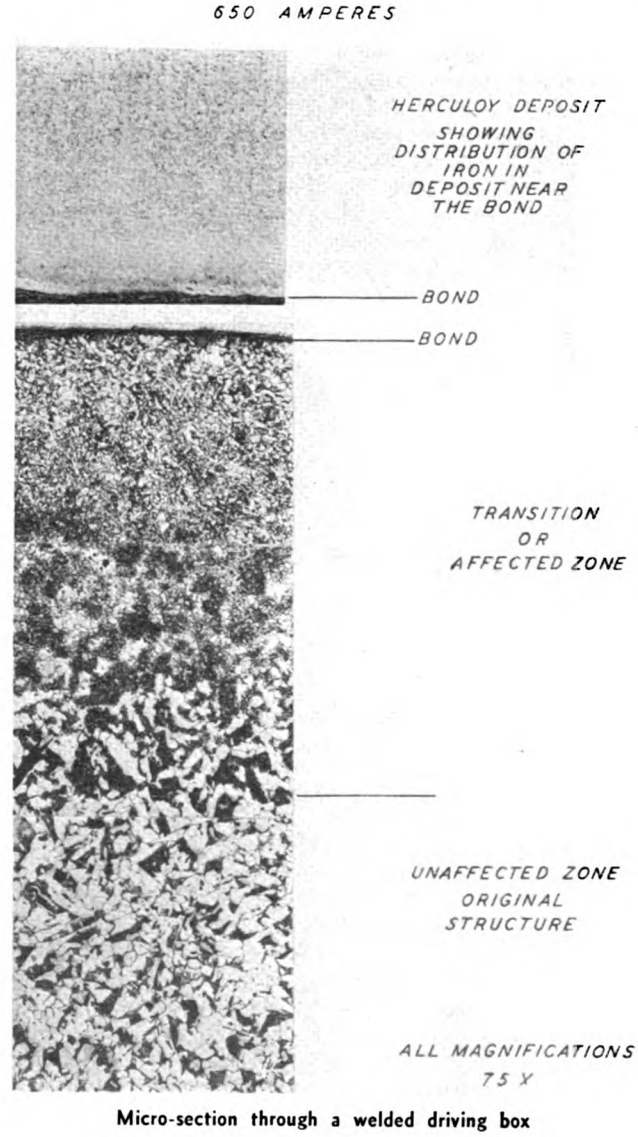
1.	Original cost per liner on dovetailed box, material off and on, old style	$9.00
2.	Original cost per liner on dovetailed box, fusion welded	12.00
3.	Original cost per liner on new boxes, fusion welded..	6.00
4.	Rebuilding cost per liner on fusion welded boxes	3.50

With the old method it was necessary to drop a pair of wheels on the average of 30,000 miles. At the present time, mileages as high as 120,000 miles, or from shopping to shopping, are obtained.

When the costs are calculated over two shopping periods and proper charges made, it is found there is a saving of $47.00 per locomotive in favor of the fusion welded job.

If new boxes are used, a far greater saving is found. The value in this case is estimated at $95.20 per locomotive in favor of the fusion-welded job.

A hidden saving of considerable magnitude is also found in the fact that the locomotive can be gainfully



Micro-section through a welded driving box

employed, rather than having the large capital investment laying idle, awaiting driving-box repairs.

Other Welding Applications

There are many other places in locomotive repair shops where welding rods and operations of the character described can be suitably employed. The combination of the electric arc and a suitable alloy produces minimum costs and maximum operating efficiency. Crosshead shoes, shoe and wedge faces and other places may be suitably built up and repaired using this method and this metal. Prolonged performance with minimum expense should result.

The inclusion of substantial quantities of lead in arc-deposited metals forces a complete revision of our thoughts on welding technique. Further developments, now under way, indicate that practically any of the recognized bearing alloys may be suitably deposited by means of the electric arc. Such depositions result in a bearing material which is in many cases markedly superior to the standard cast form. Due to the rapid chilling effects of the electric arc, the grain structure is very fine and the lead dispersion very thorough. The lead is present in small globules and more uniformly distributed throughout the mass of the deposited metal than in the case of castings, thus resulting in better physical properties and better bearing properties.

A research and test program indicates that arc-deposited bearing bronzes possess tensile strengths as great as 50 per cent higher than the same alloy cast or oxyacetylene deposited. The Izod impact values, a measure of toughness and shock resistance, are better than 50 per cent higher than cast bronze and over twice the values obtained from oxyacetylene deposits. The hardness values likewise are much higher for the arc-deposited metals and the loss of metallic constituents lower.

There appears to be much promise for arc-deposited bearing bronzes, and continued development and research will no doubt, extend our present knowledge and ability.

The author wishes to thank the New York Central, the Baltimore & Ohio, and the General Electric Company for permission to use certain data and information. Their cooperation is duly appreciated.

Handling of Material And Locomotive Parts

Materials and locomotive parts, at the Huntington locomotive shops of the Chesapeake & Ohio are delivered and handled by the supply department, which practice has been in successful operation for several years. All material used in repairing locomotives is taken and delivered as near as practicable to the point of use. Schedules have been worked out whereby delivery trains will leave various material sections at regular intervals and will set off loaded trailers or skids at designated points outside of the principal shop; these trailers or skids are then handled by trailers, lift trucks, or power trucks assigned to these shops. Material requisitions are telephoned to the delivery clerk's office, at which time the foreman states where the material is to be delivered, which point may be designated by engine number, pit number, shop machine number, or other special locations where space is available.

The supply department operates tractors or power trucks in each of the important shops for the purpose of distributing material, transporting material or parts from one location to another, and setting out loaded and empty trailers for the main-line tractor trains. The shop forces handle the movement of all material which can be moved economically with overhead cranes, wagons, and trucks.

The "spot" system is used in the Huntington shops on shop material transported from gangs to engines or other

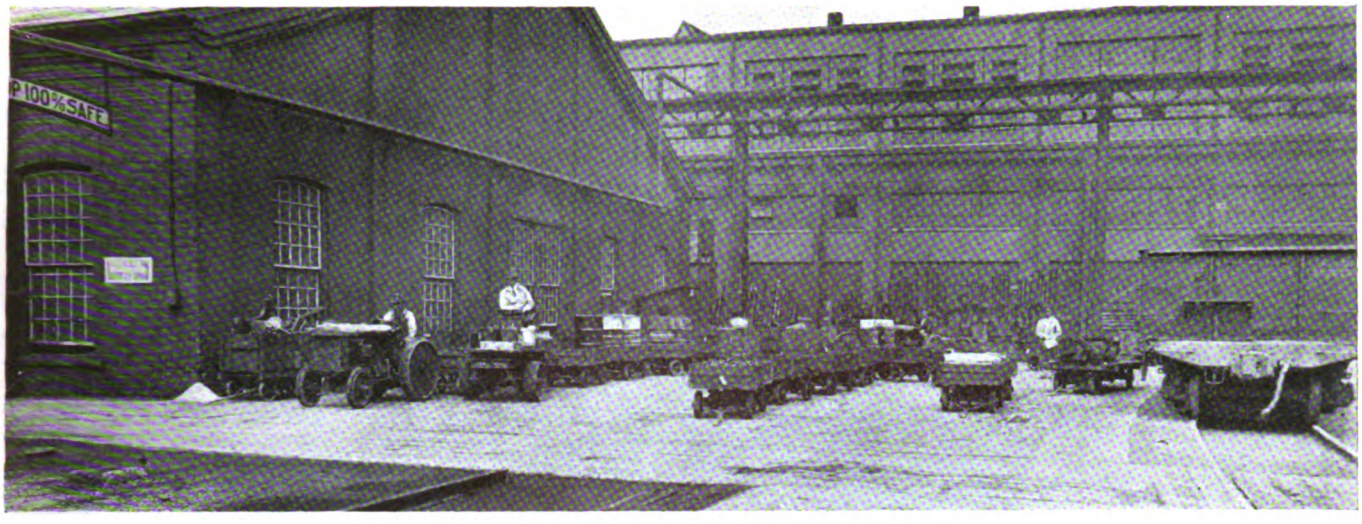


Skids for handling brake rigging

points. Each foreman places material on the "spot" and a flat power truck picks it up on scheduled trips through the shop. When the material is too heavy to be handled by this power truck, a cross order is placed in the foreman's station box covering a request for handling the load. A messenger boy, on an assigned route, picks up these cross orders and delivers them to the shop transportation foreman. These pickups from points outside the shops are telephoned to the transportation dispatcher's office.

List of Material-Handling Equipment at the Huntington Shops

No.	Type
Trucks and Trailers:	
1	Gas-electric Hi-Lo
1	Gasoline truck
3	Electric tractors
1	Gasoline tractor
3	Power lift trucks with booms
3	Hand lift trucks
3	Crane trucks
3	Plain flat trucks
852	Trailer wagons, all kinds
Skids:	
30	Live skids with casters
357	Box type, factory made
2	Box type, shop made
10	Wood, box type, shop made, four-leg
10	Platform type, shop made, four-leg
24	Low box compartment, cab mountings
8	Oxyacetylene equipment
22	Driving springs
34	Air pumps
63	Brake rigging and spring rigging
4	For handling material when shipped by baggage
4	Feedwater Heaters
22	Engine jacket
1	Staybolts
1	Long, for rods
21	Engine diaphragm material
25	Tall, four-leg, for hot metal
Miscellaneous Trucks and Wagons:	
8	Baskets for handling locomotive pipe at lye vat
25	Wagons for handling locomotive pipe from shop to storage. Pipe remains on wagons until returned to shop and applied to locomotive
4	Metal containers for handling journal bearings in locomotive tank shop
2	Wagons for handling storage batteries in the passenger-car shop
20	Wheel buggies for handling tender truck and car wheels
4	Wheel buggies for handling driving and trailer wheels
2	Lift trucks used in handling skids in blacksmith shop
1	Truck for handling rods and driving boxes
1	Truck for handling locomotive tires



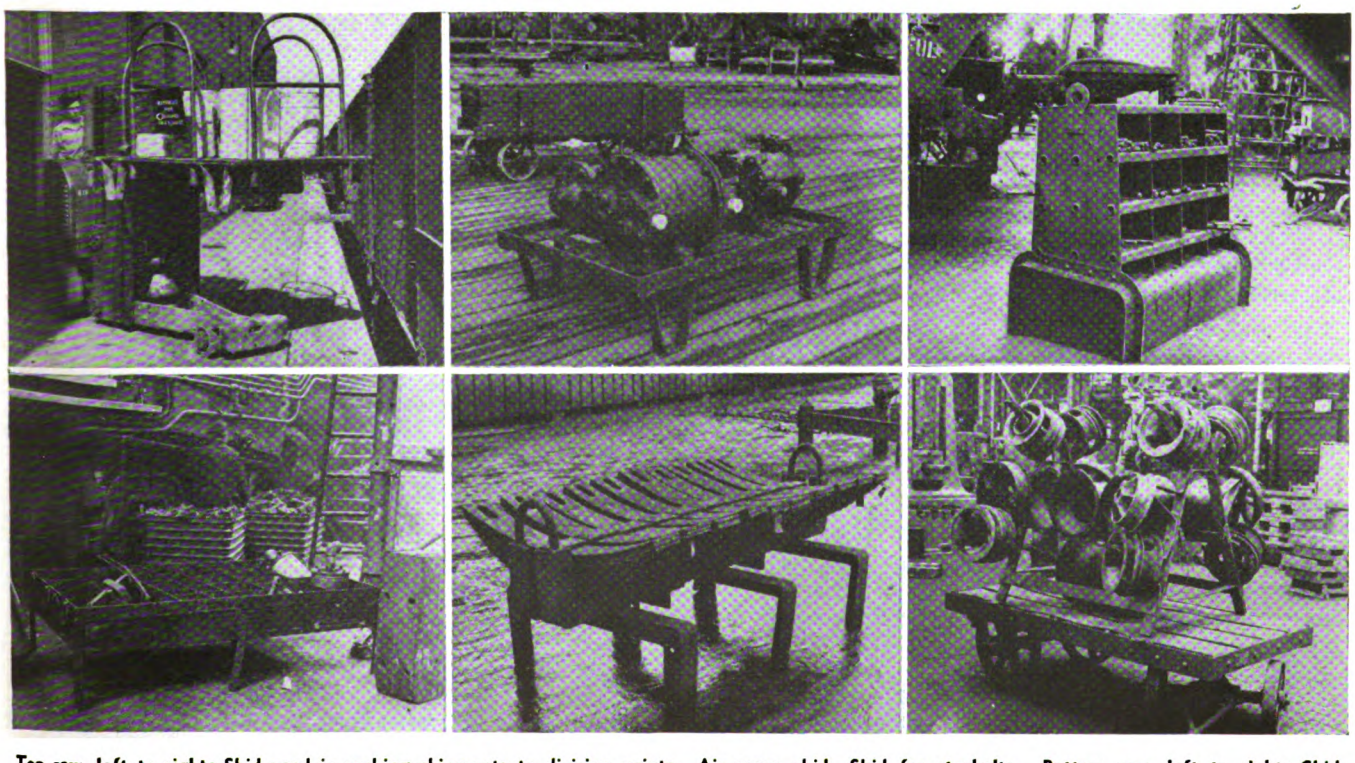
Central station from which all material is distributed

When empty trailers or skids are ordered to be placed for loading, the shop forces do the loading, and when loaded an order will be placed in the station box for movement. The supply department hauls the trailers or skids to their destination and where space is available, and when unnecessary handling can be eliminated, the trailer or skids will be left to be unloaded by the shop forces; otherwise, the trailers or skids will be unloaded by the supply department, except where shop cranes are available for this purpose. When the hauling is done on power flat trucks, the loading and unloading is done by the supply department, except where cranes are available.

A storage platform, located centrally at the south end of the blacksmith shop and east of the storeroom, is provided for empty trailers and skids; except those designed for a special purpose, which are stored near the respective shops. In order to relieve shop congestion and to provide sufficient equipment, all trailers and skids are promptly unloaded and returned to storage places, unless unnecessary handling of material is involved.

Cleaning Shops and Handling Scrap—The mechanical department provides sufficient force and supervision to do the general shop cleaning on the first shift. A sufficient number of trailers are placed in the shops to handle all scrap and debris, the loading of which is done by shop forces. The handling and unloading is done by the supply department forces on the first shift. The shops are operated on a five-day week at present. A necessary force is retained on Saturdays to clean the shop and handle material in the shop.

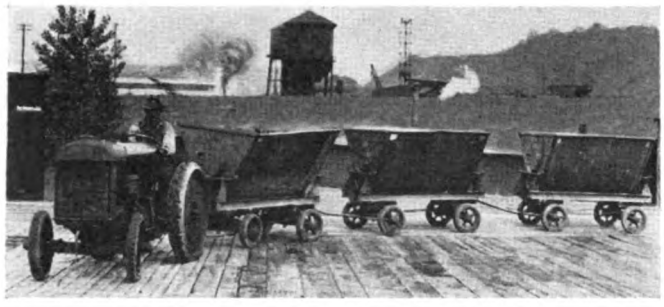
Equipment—Equipment for handling material in the shop, storing and shipping materials to outside points consists of a number of different designs of skids which are handled by power lift trucks. In some instances these skids are used to ship bulk manufactured materials, such as rivets, brake shoes, and journal bearings to the general store. A list and description of the equipment



Top row, left to right: Skid used in making shipments to division points—Air-pump skid—Skid for staybolts. Bottom row, left to right: Skids for grates and boiler mountings—Skid for handling springs—Wagon and rack used in sand blasting piston-valve parts

now being used in handling material, scrap, and debris, is given in the accompanying table.

Machines for Handling Material—Of the physical equipment furnished the stores department for storing and shipping materials, the lift and platform powered trucks are most useful. The skid boxes are used for



Dump wagons used in handling shop refuse, sand and gravel

storing material at the general storeroom, for shipping materials to outside points, and for shipping bulk materials such as rivets, brake shoes, and journal bearings from the point of manufacture to the general storerooms. With the use of platform and lift trucks the loaded skid boxes, containing from 3,000 to 6,000 lb. of material, can be moved in and out of cars and from storeroom to points of use with less human effort than was formerly required to handle a 200-lb. keg of rivets or bolts.

Locomotive Boiler Questions and Answers

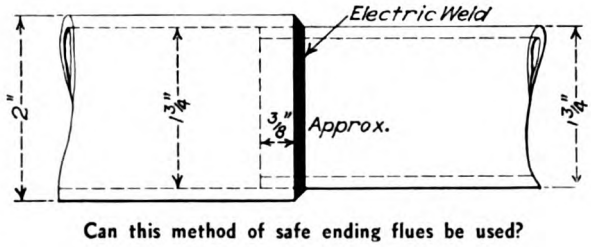
By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Safe-Ending Flues of Different Diameters Not Recommended

Q.—The accompanying sketch shows a method of safe ending locomotive flues with a smaller diameter flue, the small end to go in the firebox tube sheet. This will eliminate swedging the tube and will also get more water to the firebox tube sheet. I would like to have your comments on this method.—M. McN.

A.—In this design, the chief difference from the conventional manner of safe ending flues, is that one tube is inserted inside of the other and secured with electric weld on the outside, while the conventional manner is to butt weld the safe end to the tube in an electric flue welder. Of the two methods I believe that butt welding the safe ends in an electric flue welding machine would be the most economical even when taking the swedging operation into account. In the proposed method, the variations in the diameters of the tubes would have to be taken into account if a snug fit is to be obtained. The chief objection would be that the safety of the structure is dependent upon the strength of the weld, and before making any application of safe ends in accordance with the method outlined, I would suggest the sketch be submitted to the inspector, under whose jurisdiction the flues come, for approval.



Can this method of safe ending flues be used?

Types and Efficiencies of Longitudinal Seams

Q.—What are the different types of longitudinal seams used in locomotive boiler construction?—V. J.

A.—Four different types of longitudinal seams are in use, viz., sextuple, octuple, decuple and diamond-shaped seams, the first three being the most common. In the order named, they have approximate efficiencies of 82 to 85 per cent, 87 per cent, 93 per cent and 98 per cent. The diamond seam, at almost 100 per cent efficiency would appear to be the most advantageous and does reduce the thickness of the shell, thereby reducing the weight and cost of the plates; however, the inner welt of this type of seam has to be quite extensive in size, and the weight saved in the shell itself is mostly replaced by the weight of the inner welt strip. The size of these welt strips is also a disadvantage in that it frequently causes the strip to interfere with some accessory or fitting requiring rivet or stud bolts in the shell. Furthermore, to place these holes through the seam in line with any of the seam rivets in the inner welt strip would reduce the efficiency of the seam.

Steam Evaporated by Different Boiler Sections

Q.—Have you any late data on the large up-to-date locomotive boiler pertaining to generation of steam? I would like you to give a comparison of steam evaporated by the different sections of the boiler.—J. C.

A.—The heating surfaces of firebox boilers of the locomotive type are classified according to direct and indirect heating surfaces. The crown, side, door and flue sheets and arch tubes are exposed directly to the fire; therefore, they are known as direct heating surfaces. The tubes and flues are exposed to the heat from the gases

Evaporation From Tubes and Flues of Various Diameters and Spacings

	Tube or Flue Diameters, in.								
	2			2¼			5⅜ and 5½		
	Spacing, in.			Spacing, in.			Spacing, in.		
Length, ft.	⅝	¾	1	⅝	¾	1	⅝	¾	1
	Evaporation, lb. per hr. per sq.ft. of outside surface								
15	9.44	9.97	10.80	10.02	10.51	11.29	11.55	11.65	11.90
15½	9.27	9.78	10.63	9.83	10.33	11.09	11.35	11.46	11.71
16	9.10	9.60	10.44	9.67	10.15	10.90	11.17	11.28	11.52
16½	8.94	9.42	10.25	9.50	9.97	10.71	10.99	11.11	11.34
17	8.78	9.27	10.07	9.34	9.80	10.55	10.82	10.94	11.16
17½	8.62	9.11	9.89	9.18	9.63	10.35	10.65	10.77	10.99
18	8.47	8.95	9.72	9.03	9.46	10.18	10.49	10.60	10.82
18½	8.32	8.79	9.55	8.88	9.29	10.01	10.33	10.44	10.66
19	8.18	8.63	9.38	8.73	9.12	9.84	10.17	10.29	10.51
19½	8.04	8.47	9.21	8.58	8.97	9.68	10.02	10.14	10.35
20	7.90	8.32	9.05	8.44	8.83	9.51	9.88	10.00	10.22
21	7.63	8.02	8.73	8.15	8.55	9.19	9.60	9.72	9.94
22	...	...	...	7.90	8.28	8.90	9.33	9.44	9.66
23	...	...	...	7.66	8.03	8.62	9.08	9.18	9.38
24	...	...	...	7.42	7.78	8.35	8.83	8.94	9.12
25	...	...	...	7.20	7.55	8.10	8.60	8.70	8.90

NOTE: By spacing is meant the distance between the tubes or flues after they are installed in the boiler. This should not be confused with the spacings in the tube sheet between the holes, which is known as the bridge; the spacing between the tubes is different from the bridge distance because of the swedged ends of the tubes.

which pass through them, but not directly to the fire; therefore, their surfaces are considered as indirect heating surfaces in calculating the entire heating effect.

Tests have shown that a heating surface in a horizontal position is more efficient than an equal area of vertical heating surface and that a heating surface in direct contact with the fire will evaporate water at a higher rate than an equal area subject to indirect heat. The heating surfaces of the firebox of locomotive-type boilers will evaporate about 55 lb. of water per sq. ft. of heating surface per hr. The evaporation by the tubes and flues is estimated roughly about 10 lb. per sq. ft. of outside surface per hr. The actual evaporation by tube and flue surface is variable, depending on their diameter, length and spacing. Some of the values of water evaporated per square foot of outside heating surface per hour for some tube sizes and spacing are given in the accompanying table. These data were compiled by the American Locomotive Company.

Flame Cutting of Rivets and Staybolts

Q.—What is the best procedure for cutting out rivets and staybolts with an oxyacetylene torch?—M. K.

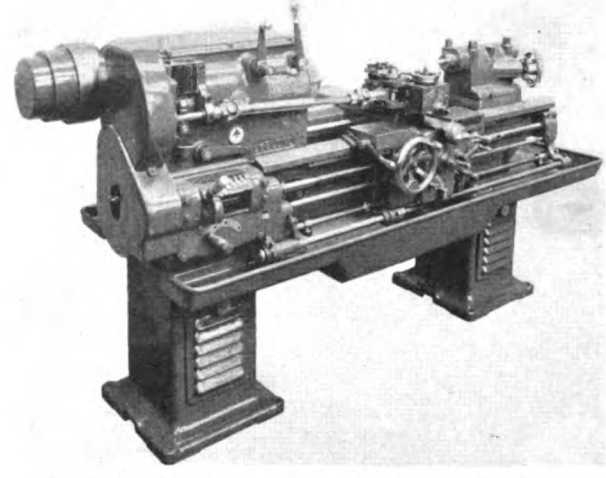
A.—In removing staybolts by the flame-cutting process, the tip is held in line with the bolt, so that the preheating flames contact and heat the edge of the telltale hole. When heated sufficiently the cutting oxygen is turned on gradually. The blow pipe is slowly rotated around the telltale hole until the center of the bolt is consumed for a depth of ⅜ in. The direction of the cut is changed 45 deg. and the bolt pierced through to the water space. By slowly rotating the torch or blow pipe at the same angle the bolt is cut without damage to the sheet of threads. The small burr remaining the sheet is then removed. There are several other fast economical methods of applying the flame-cutting process to this operation which can be and are used to meet special jobs or shop conditions.

In rivet cutting by surface oxidation of heads, the cutting tips used have large cutting oxygen orifices of the expanding low-pressure low-velocity type, together with high-intensity preheating flames. The tip is held in line with the rivet, close to the head, so that preheating flames impinge on its center. As soon as a spot is heated to a bright red, the cutting oxygen is turned on slowly. This quickly oxidizes a crater in the head and consumes it. The shank of the rivet is then knocked out of the hole. Preheating and oxidation of the rivet head require only a few seconds and unusual speed and economy are secured by this method, particularly where large quantities of closely spaced rivets are cut. The low velocity and pressure of the cutting oxygen are insufficient to cause the molten slag to fly back against the end of the tip and plug up the holes so that the torch need not be raised when turning on the cutting oxygen. Plates or sheets are not scored by this improved method.

Relieving Attachment For Tool-Room Lathes

The R. K. LeBlond Machine Tool Company, Cincinnati, Ohio, has developed a universal relieving attachment for tool-room lathes which increases the application of the lathes with the use of only two cams, makes it possible to obtain any relief from zero to ¼ in., and provides means for accomplishing external, cylindrical, internal, end, side, angular and spiral relief. The majority of the work within the range of the attachment can be handled without angularity of the knuckle joints which, under the most extreme conditions, assume only a slight angle. No supporting blocks or additional knuckle joints are necessary to change from external to internal or end relief; for spiral relief it is only necessary to make a simple adjustment of the change-gear combinations. With the built-in coarse threading attachment, which is always furnished with the relieving attachments, most of the change-gear combinations can be made directly from the quick-change box.

The driving mechanism is attached to the headstock



The LeBlond tool-room lathe with relieving attachment

and in no way interferes with the operation of the lathe for ordinary work. The drive from the gears on the end of the lathe is through a telescopic shaft to the actuating mechanism on the tool slide. The tool slide replaces the regular compound rest and incorporates the same swivel feature, enabling the operator to swivel the slide to the proper angle for angular, side and end relief.

The actuating mechanism is driven by a pair of hard-miter gears, one of which is keyed to the cam shaft. The driving gear can be swiveled about the center of the driven gear since it is mounted in a swivel bracket with a positive means for clamping it in the desired position. With this construction, the driving shaft remains straight regardless of the angular setting of the tool slide.

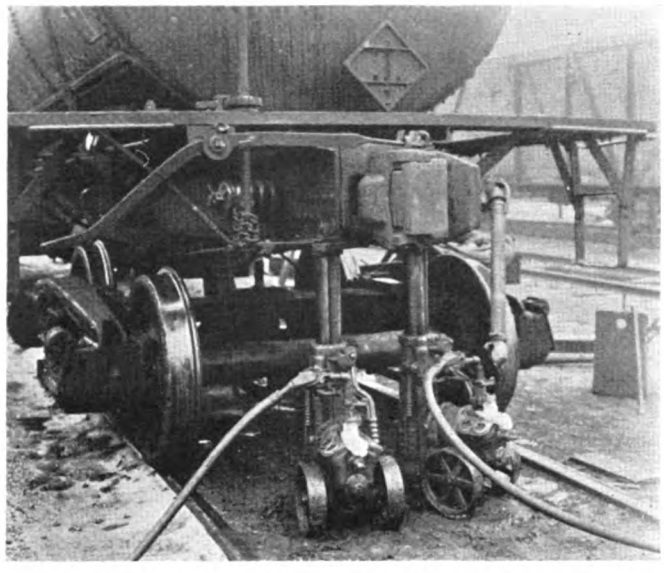
The driving cam, revolving constantly, imparts an oscillating motion to the follower cam that is mounted on the vertical eccentric shaft which may be adjusted in relation to the follower cam by the square milled on the upper extension of the shaft. This shaft, which is oscillated under the influence of the master cam and follower cam, imparts the reciprocating motion to the tool slide by means of the eccentric which is formed on it and a positive connecting rod to the tool slide. The motion imparted to the eccentric shaft being constant, the variation in the stroke of the tool is accomplished by adjusting the eccentricity of the vertical shaft in relation to the follower cam. As the line of eccentricity approaches parallelism with the ways of the tool slide, the stroke of the slide is decreased, and when adjusted to the maximum effective throw of the eccentric, the stroke of the slide is lengthened to provide the greatest amount of relief.

The driving gears are completely guarded. An extra compound rest and standard tool post are regularly supplied with each lathe equipped with the relieving attachment.

With the Car Foremen and Inspectors

Wheel Changes Expedited

In making wheel changes at the Chicago & North Western car-repair tracks, South Proviso, Ill., the first operation, namely, jacking the car, is greatly expedited by the use of power jacks, which are especially helpful in the case of cars with heavy loads. Two of these jacks, shown in one of the illustrations, are of the Joyce-Cridland 50-ton type, operated by directly-connected Ingersoll-Rand air motors. These motors operate simultaneously, being connected to the same air line through a single valve. Both sides of the car are accordingly raised at the same rate and a mechanical over-travel trip is provided to avoid any possibility of the car body being jacked above a safe height. When it is desired to lower the car body, each jack is set in reverse and continued operation of the air motors lowers the load. These jacks are provided with substantial bases so as to require a minimum of blocking. Safety is assured since the load is fully sustained, even in the event of loss of air pressure.



Power-operated jacks raising a loaded tank-car body preparatory to changing the wheels

It is difficult to estimate how much saving will be accomplished by modern power-operated jacks in car-repair yards. With the larger capacity jacks the rate of lifting the load is relatively slow and possibly not much faster than would be the case with hand-operated jacks. From the point of view of manual labor involved and safety, however, there is no question that the power-operated jacks are vastly superior.

While the principle of the truck assembling and dismantling device is by no means new, the particular design, illustrated in two views, is notable for its rigidity, relatively light weight and the fact that it can be readily separated into three pieces and, therefore, easily moved from one part of the repair track to another. The general dimensions of the device are fairly well standardized, it being 10½ ft. wide between side frames, 69 in. high under the lower horizontal cross pipe and 84 in. high overall. To assure maximum strength combined with light weight, welded tubular construction is used throughout.

Each A-type side frame is made of two pieces of 1¼-in. extra-heavy pipe, bent parallel at the top where they are welded together and reinforced with two 5-in. by 10-in. steel cover plates. The inner plate is machined or cut away so as to form a T-slot, 8 in. long, which accommodates a T-iron connection rigidly welded to the ends of the cross pipe assembly. The closeup view of the device shows a car man slipping one end of the cross pipes into the T-slot in the A-frame. The A-frames are braced with 1-in. horizontal pipe sections, located about 30 in. above the ground, and each pipe leg is covered at the bottom with a 2-in. circular steel plate, welded in place and providing adequate support for the device on reasonably firm ground.

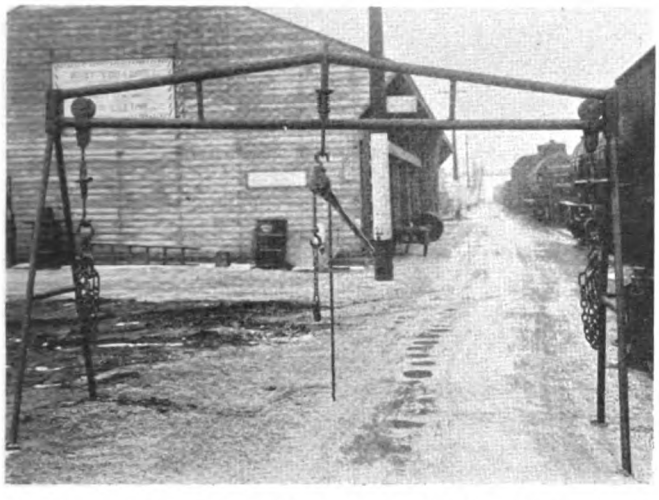
The horizontal cross-pipe assembly consists of 2-in. extra heavy pipe, made in the form of an inverted truss and braced with three 1-in. pipe struts welded in place. As usual, a lifting device is provided at each of three points so that the truck bolster and two side frames may be lifted simultaneously, and the latter moved along the horizontal cross bar in dismantling and reassembling the truck. A ¾-in. turn buckle, with extension handle is suspended from a 5-in. shieve wheel at each end of the device, being, therefore, capable of easy movement horizontally within the necessary limits in moving the side frames. The connection of the center lifting device is of unusual interest owing to the fact that the Coffing chain hoist is suspended from a spring-supported steel yoke made of ⅝-in. stock, which completely surrounds the cross-pipe assembly and, therefore, serves as a safety loop in case the spring connection fails. This feature is best seen in the close-up view already referred to.



Method of applying the cross-pipe end in the A-frame T-slot

The advantages of this general type of truck assembling and dismantling device have been quite thoroughly demonstrated. Not only are wheel changes made quicker and all truck repairs expedited, but the greater ease of removing side frames enables this operation to be performed with less danger of damaging the journals or injuring fingers and hands. A substantial reduction in the cost of wheel changes and truck repairs is effected by the use of this truck assembling and dismantling device.

Wheel trailers of the type shown in the last two illustrations are used at the South Proviso car-repair yards to facilitate handling wheels to and from storage tracks. This two-wheel trailer is very substantially made of steel,



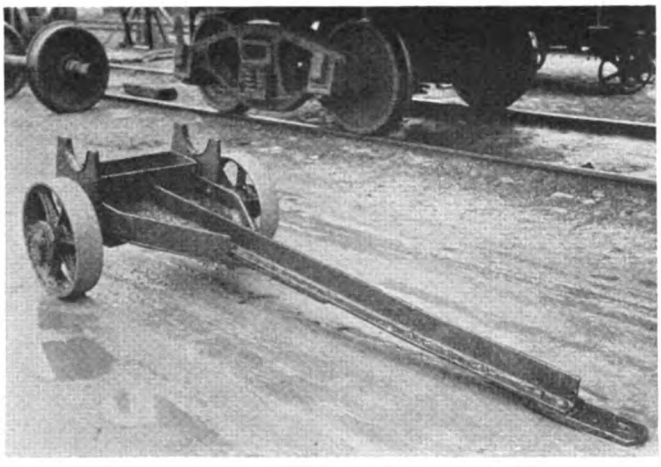
Truck assembling and dismantling device notable for light but strong construction

so proportioned and designed that it can be pushed under a pair of car wheels resting on the ground, at which time the tongue of the trailer extends upward at an angle of about 45 deg. Simply pulling down the tongue has the effect of raising the wheels clear of the ground, after which the tongue can be coupled to a tractor and the car wheels moved wherever desired about the repair tracks.

Referring to the view of the trailer unloaded and



Two-wheel trailer and tractor used in moving car wheels about the car-repair yard



The car-wheel trailer

uncoupled from the tractor, its general construction is apparent. The axle is 42 in. long, overall, and the roller bearing wheels are 18 in. in diameter with 4 in. threads. The tongue, a 4-in. T-iron, 7 ft. long, is riveted securely to the steel trailer body, made of a section of 5/8-in. steel plate reinforced with 4-in. bent angles, to which the 1-in. axle-supporting plates, spaced 24 in. apart are firmly riveted. Half-round recesses, 7 in. in diameter, are cut in the side plates so as to support the bottom of the car axle 18 in. above the ground. Between the side plates and under the axle there is just room for a small steel box which provides a convenient means for carrying car brasses, truck bolts, etc. The trailer is hauled by the usual power-operated tractor and its use assures the safe and satisfactory handling of car wheels about the repair tracks.

Car Service Rules And Per Diem Rates*

By J. L. Brown†

With every index pointing to higher costs for materials and supplies, higher labor costs and higher taxes, it is quite apparent that we must secure the maximum use for all classes of equipment.

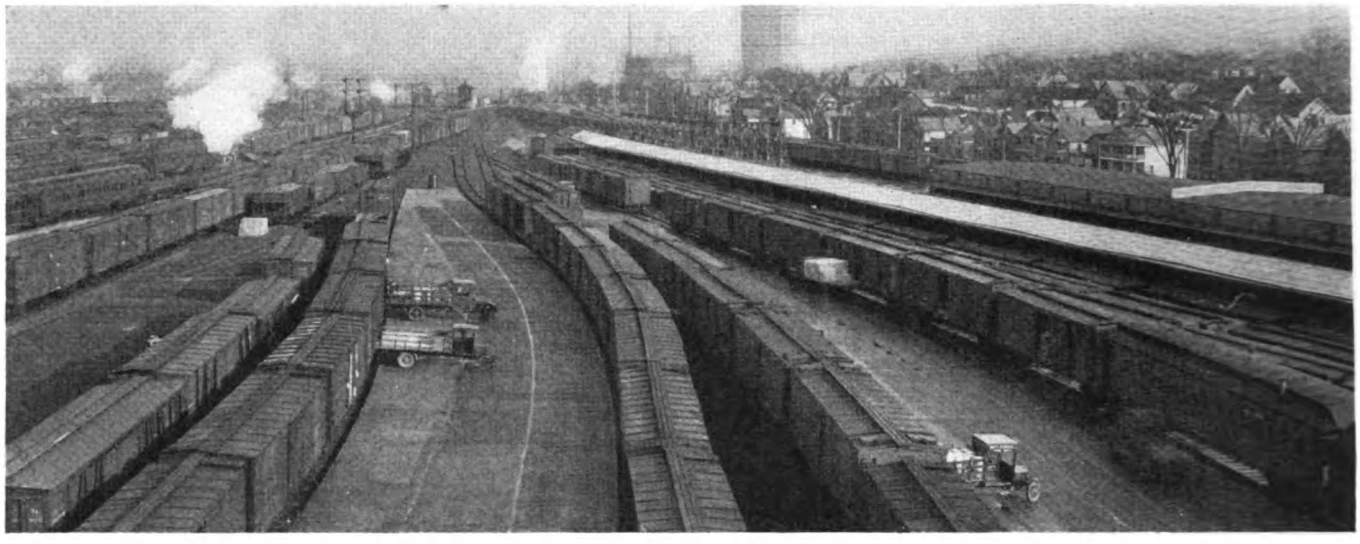
The first car service rules became effective about 1893. They are fundamentally the same now as they were then, with improvements and additions as experience has indicated was necessary. These rules were adopted at a time when mileage payments were the basis of car rental. On July 1, 1902, the per diem plan became effective with rates varying from 20 cents per car per day with a penalty rate when cars were detained more than 30 days, rates being increased or decreased until March 1, 1920, when the rate was increased to 90 cents per car per day, subsequently increased on November 1, 1920, to the present rate of $1.00 per day, with the exception of May 1, 1935, to June 31, 1937, when the rate on plain and ventilated box cars was settled for on an arbitrary, based on monthly averages, because of the adoption of the average per diem plan on this class of equipment.

It is appropriate at this time to call attention to the fact that on May 1, 1917, all A. A. R. car service rules

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* Abstract of a paper presented at the December, 1937, meeting of the Car Foremen's Association of Chicago.

† General superintendent transportation, Chicago, Milwaukee, St. Paul & Pacific, Chicago.



Car service rules and per diem rates have an important bearing on the service secured from freight cars

were suspended by general order CS-1. In June, 1919, the Committee on Car Service, Transportation Division, together with representatives from several regions, formulated a code of car service rules to govern the handling of freight cars upon the termination of federal control. These rules were based on the original principles of ownership.

They were adopted by the association March 1, 1920, on release from federal control and their application became a matter of signed agreement executed by the executive officer of each railroad, a copy being filed with the Interstate Commerce Commission. In this agreement there was added further flexibility under per diem Rule 19, with the appointment of the Car Service Division who were given authority to supervise and suspend the rules and to provide other regulations under which cars shall be handled. This action might become necessary under extraordinary conditions.

Because of experience under these rules, the Board of Directors of the A. R. A. on January 6, 1921, passed the following resolution:

"That the Transportation Division be requested to bring in as soon as possible a set of car service rules which will bring cars home under reasonable conditions and without unnecessary delay, or back haul or otherwise, and with adequate penalties for non-observance, the division to be requested to consider the question of equity as between loaded and empty car."

On July 1, 1921, the present car service rules with slight exceptions were adopted and with the $1.00 per diem rate effective November 1, 1920, provided an incentive to expedite the movement of equipment to owners' rails.

The car service rules at present total 17. The most important, in my opinion, resulting in proper car handling, are Rules 1, 2 and 3.

Rule 1.—Covers what is known as "home cars," for example, a Milwaukee car on Milwaukee rails. These cars should not be used for the movement of traffic beyond the limits of the home road when the use of other suitable cars is practicable. The last two words "is practicable" have their opponents as well as defenders. A sincere effort in the application of this rule will accomplish much. A mere review of car location statements does not indicate a compliance or non-compliance. Conditions on many lines vary and reasonable latitude as to the use of foreign and home cars, with due regard to size, condition and type of cars, peak and valley seasonal movements, loaded and empty car mileage, and all other factors adversely effected by an iron-clad rule must be considered.

Rule 2.—Covers foreign cars at home on a direct connection, for example, a B. & O., C. & N. W., or C. B. & Q., car located on Milwaukee rails, these being cars of direct connections. This rule provides some seven ways in which to dispose of such equipment either loaded or empty.

An important part of this rule provides: "If empty at junction with the home road and loading at that point is not available, such cars must be delivered to owner at that junction, unless an exception to the requirement be agreed to by roads involved."

An honest compliance with this provision will materially help the car supply of the owners; will be helpful in reducing car service rule violations, and in many cases be of assistance in reducing the ratio of empty to total car miles.

Rule 3.—Takes care of foreign cars on other than direct connections and provides for proper handling of such equipment. For example, cars owned by the New Haven, the Florida East Coast or the Texas & Pacific, located on Milwaukee rails, are cars of other than direct connections. This rule in particular has been given additional study and supplemental instructions have been issued to all roads by the Car Service Division at Washington. They, after study with the Committee on Car Service, issued instructions looking toward a further reduction of empty car miles and providing ways and means for prompt return of such cars to owner when the service or home route is circuitous and loading in accordance with car service rules is not practical.

These instructions provide: (1) That exchange arrangements be established by roads either on a mileage basis or a car-for-car basis in disposal of empty cars; (2) that instructions be issued by individual railroads that no car subject to disposal under car service Rule 3 (d) shall be moved in an opposite direction from the home road until authorized by the proper officer; (3) when it is not practical to dispose of such empty foreign cars, reciprocal exchange arrangements, short routing should be arranged if possible without telegraphing car owner but when no such disposition is possible, car owner may be telegraphed and should promptly furnish short route record upon request, up to nearest connecting line to holding road.

As an example, on an indirect connection car, if we

received on an original record a New Haven car from the Union Pacific at Marengo, Wash., loaded destined for Aberdeen, S.D., while car service rules permit us to return this car to Marengo, Wash., it is apparent whoever originated the load complied with the instructions in loading in the direction of owner and while the rule permits return of the car to the delivering line we would take advantage of car service Rule 4 and either short route car to some junction point on our line, enroute to the owners, or by a reciprocal trading arrangement offset with some car of foreign ownership, or would wire the car owner to secure his record from the time car left his rails until it reached ours and then by arranging with some intermediate line, dispose of car without backhauling in home route in a reverse direction from owners.

Rule 4.—Governs the interchange of cars of railroad ownership with steamship and ferry lines.

Rule 5.—Covers the short route of the so-called Rule 3 cars previously mentioned herein, and is mandatory. It also provides for short routing of other empty cars by mutual arrangement between interested lines. This is an important rule and is frequently used in various parts of the country by mutual agreement.

The rule further provides for the service at a reciprocal rate of five cents a mile, plus bridge and terminal arbitraries, with a minimum of 100 miles for each railroad handling the car, the road requesting the service to pay the charges. Settlements for charges accruing under this rule are handled under bill and voucher plan.

Rule 6.—Requires, under certain conditions, return of empty cars to the home road via the junction at which cars were delivered in interchange under load. This rule is also important.

It is interesting in reviewing these rules to note that in the past 35 years many theories have been advanced as to car handling. Prominent among these was the pooling of all classes of equipment as was carried on under the period of federal control. These plans, proposals, or theories have all been given serious and careful study by transportation, mechanical, traffic and Car Service Division officers, with the result that all studies reached the conclusion that the car service rules provided efficient service to the public and leave with the individual railroads the entire responsibilty of providing an adequate car supply.

Please understand, however, that in the application of these rules they must be supervised to secure results. In times of heavy car loading one of the major duties of the Car Service Division at Washington is close supervision as between railroads, supplementing these rules with special orders when necessary, and with success.

Reason for the Average Per Diem Plan

In touching upon the average per diem plan and its history, it is not my purpose to indulge in any criticism, although a recitation of plain facts may make it appear that criticism is intended.

A great many questions have been asked in the past two years as to the cause for the adoption of this plan. I might add when this plan became effective May 1, 1935, there was no change made in car service rules, and the rules adopted in July, 1921, were continued in effect.

The average pier diem plan was adopted because of studies made by the railroads and Car Service Division, principally because of an increase in the ratio of empty to total car miles which was noted after October, 1929, due to the light car loadings.

The plan for payment provided that a check be made for the months January to December, 1932, 1933 and 1934, and when the averages for these months were determined they were applied as the car rental basis for each month in the future, which was very much less on an average than the dollar per day rate previously in effect.

With improved conditions in 1936 and the necessity of again speeding up car movements to take care of traffic, there was a great deal of concern, particularly on the part of western roads as to the longer detention of western cars off line under the average plan than under the straight per diem plan, the western lines in particular being confronted with a lesser supply of cars on line and with increased business, a member road of the Western Association of Railway Executives requested that the subject be docketed for consideration. A committee of western transportation officers including myself, was appointed under proper resolution and after careful study concluded in view of the purpose of the average plan being to save empty car movements, as a result of the light business conditions during the years 1932 to 1934 and that the average plan had accomplished its purpose in slowing up the movement of equipment to owners rails, that action should be taken at once to restore the dollar per diem rate effective July 1, 1937, speeding up the movement of cars as originally intended during periods of increased demand and return of normal conditions.

Average Per Diem Plan Suspended

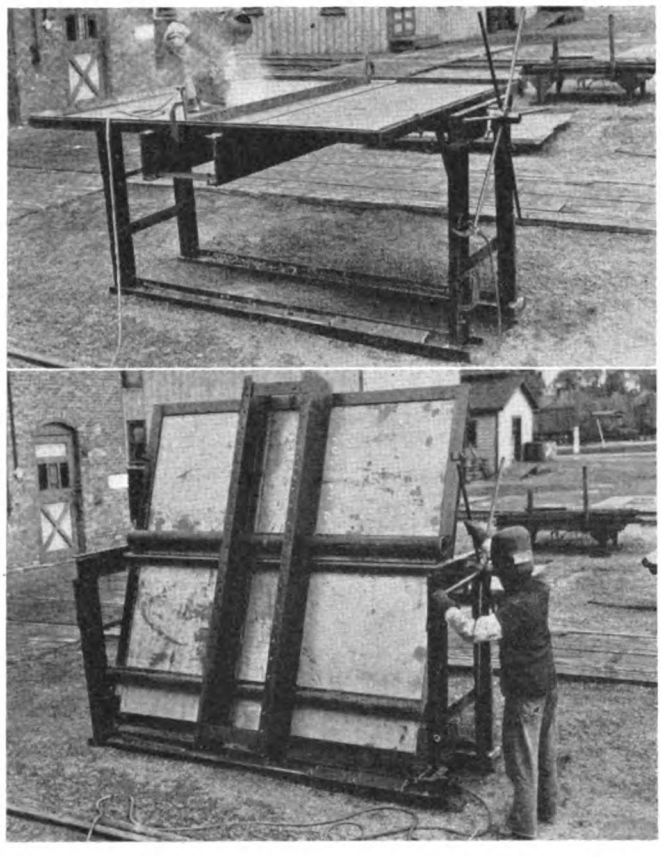
This resolution was approved by the association and transmitted to President Pelley who, in turn, after careful investigation passed the subject to the General Committee who gave the subject further consideration and submitted their recommendations to the association. Further study was continued and at a meeting of the Board of Directors on June 25, 1937, the average per diem plan was suspended for the period July 1, to December 31, 1937, providing, however, that the plan could be continued between member lines if so desired and that is the status of the average plan today. According to the order of the board of directors, the plan will automatically be restored January 1, 1938, unless other action is taken.*

Welding Hopper-Car Slope Sheets

Steel hopper-car slope sheets are being arc-welded into one unit at the welding station of the Delaware & Hudson car shops at Oneonta, N. Y., with the aid of the jig shown in the two accompanying illustrations. The bed of the jig is constructed of channel irons, reinforced with iron strips, and joined by welding. The table of the machine rotates on trunnion bearings and is reinforced by heavy channels so that, despite its own weight and that of the slope sheet being fabricated, it can be rotated with very little manual labor.

These slope sheets are made up of three sections of sheet steel, the jig having been designed so that when the three pieces are laid out side by side they just fill the jig frame. To prevent buckling during the welding operation, the three parts are locked in place by two clamps at each end, and an angle iron running the length of the

* (Since Mr. Brown's paper was delivered, the Board of Directors of the A. A. R. has suspended for another six months the average per diem plan which was in effect from May 1, 1935, until July 1, 1937. On the latter date the plan was suspended until the end of last year, which suspension is now continued until June 30.—Editor.)



Top: Welding three sections of sheet steel into one piece with jig in horizontal position—Bottom: Rotating jig preparatory to welding bottom supports, consisting of sections of reclaimed locomotive flues, in place

middle section which is also clamped down very tightly.

After the three sections are joined by welding, the jig is rotated so that supports can be welded to the bottom of the slope sheet. These supports, by the way, consist of sections of locomotive flues, which, although no longer serviceable in a boiler, will serve this purpose admirably. The finished sheet is picked up by the tractor and taken to the car-construction station where it is lowered into place. As it would be impossible to weld the sheets on the car itself, the jig not only enables the carman to do a job which could not be done without it, but also greatly reduces the time and labor formerly taken to make slope sheets.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.A.R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Repairs Claimed Excessive and Unwarranted

A Seaboard Air Line steel flat car was given heavy repairs by the Southern on August 22, 1935, at a cost of $155.09, which included $8.45 for truck repairs and $146.64 for renewal of decayed flooring and handling sills.

The Seaboard Air Line contended that the car should have been sent to its home shops, inasmuch as they were located only 46 miles from the point on the Southern where the repairs were made. The owner pointed out that the car, while loaded, had made extensive trips over the Southern lines and after unloading had been moved 32 miles to the Southern shops. Therefore, it contended that that car could have been sent to the home shops as easily as it could have been moved to the Southern shops where repairs were finally made. For these reasons the Southern contended the repairs as made were unnecessary to get the car home, and the costs, excluding those for truck repairs, should be cancelled. However, the Southern pointed out that, after the car was unloaded, part of the flooring was found to be missing and that the entire remaining flooring was found badly decayed and in such condition to make the car unsafe for trainmen. It was decided, by the Southern, that repairs necessary to make the train safe for trainmen could not be made at a reasonable cost and it proceeded to make complete repairs to the car. Inasmuch as the car was repaired in accordance with the original construction of the car and practically all of the cars of the same series were being maintained by the Seaboard Air Line, the Southern contended that the repairs were justified and that no violation of rule 1 was involved.

In a decision rendered on April 8, 1937, the Arbitration Committee stated "The Southern was justified in making repairs to the extent indicated in the agreed statement of facts, at its nearest available repair track, in order to make the car safe for its trainmen. The contention of the Seaboard Air Line is not sustained."—*Case No. 1755, Seaboard Air Line versus Southern.*

Questions and Answers On the AB Brake

Cleaning, Lubricating and Testing (Continued)

260—*Q.—How can the service-portion springs be identified?* A.—By means of the following table:

Description	Piece No.	Outside diam., in.	Wire diam., in.	Free hgt., in.	No. of coils	Material
Graduating valve	93940	0.1607	0.0201	0.656	11	Phosphor-bronze
Piston	94835	0.7910	0.0720	2.328	9	Phosphor-bronze
Return spring	95026	1.8440	0.1562	3.701	6	Steel
By-pass checks	93926	0.8071	0.0571	1.406	4	Phosphor-bronze
Limiting and back-flow checks	94852	0.4730	0.0359	0.922	5	Phosphor-bronze
Limiting - valve diam. spring	95023	1.1440	0.1280	2.984	8	Steel
Release - valve plunger spring	95025	0.9276	0.0985	2.938	9	Steel
Release check - valve spring	93972	0.5571	0.0571	1.469	6	Phosphor-bronze
Release inshot - valve spring	96026	0.4850	0.0475	1.219	8	Steel

261—*Q.—During the assembling operation, how should the slide and graduating valves be lubricated?* A.—The slide and graduating valves and their respective seats should be lubricated with triple-valve dry air-brake graphite; the slide valve spring bearing in the bushing should be lubricated in the same manner.

262—*Q.—What method should be used to apply this lubricant?* A.—A small wooden paddle with one end covered with chamois should be used to apply the graphite.

263—*Q.—How is this accomplished?* A.—By placing a small quantity of graphite on the chamois, rubbing the

seat surfaces until they become a dark copper color; no free graphite must be left on the surfaces.

264—*Q.—What precaution must be observed during this operation?* A.—These parts must be free from oil or grease.

265—*Q.—How should the piston ring and the bushing be lubricated?* A.—Three drops of antifriction oil should be placed in the ring groove, and the ring rotated to distribute the oil. Insert the assembled piston and the slide valve in the bushing to release position, then lubricate the bushing sparingly. After moving the piston back and forth in the bushing several times, any surplus oil on the bushing should be wiped off.

266—*Q.—What must be done previous to the removal of the main piston in the emergency portion?* A.—The upper cover should be removed to permit removal of the diaphragm strut.

267—*Q.—Why is this necessary?* A.—Since the strut holds the slide valve on its seat, removal of the side and the piston would be prevented until the strut has been removed.

268—*Q.—How are the springs behind the emergency vent valve and the inshot valve held in place?* A.—By circular metal retainers having lugs on two opposite sides which engage under lips in the body casting.

269—*Q.—How are the springs and valves removed?* A.—By pressing down the spring retainer and tilting it so that one lug is freed from the lip, permitting removal.

270—*Q.—When cleaning the emergency portion, what method should be followed?* A.—The same as recommended for the service portion.

271—*Q.—In regard to the emergency portion, what exception should be taken when cleaning the chokes?* A.—Three of the chokes are not readily removable; therefore, they should be cleaned in place.

272—*Q.—What three chokes are involved?* A.—The vent-valve piston choke, the diaphragm spill-over choke, and the spill-over check-valve choke.

273—*Q.—How may the springs in the emergency portion be identified?* A.—By means of the following table:

Description	Piece No.	Outside diam., in.	Wire diam., in.	Free hgt., in.	No. of coils	Material
Accelerated emergency release check valve	94952	0.7440	0.0720	1.4063	4	Phosphor-bronze
Spill-over check valve	94581	0.4790	0.0285	1.1000	5	Phosphor-bronze
Strut-diaphragm spring	94839	0.6891	0.0641	1.1250	4	Phosphor-bronze
Vent-valve spring	81643	1.3750	0.1250	2.7188	6	Steel
Inshot piston spring	95032	1.1920	0.0985	2.6406	5½	Steel
Inshot check-valve spring	94836	0.5216	0.0508	1.7188	12	Phosphor-bronze
Emergency piston spring	94835	0.7910	0.0720	2.3280	9	Phosphor-bronze
Graduating valve spring	93940	0.1607	0.0201	0.6563	11	Phosphor-bronze
Return spring	95026	1.8440	0.1562	3.7010	6	Steel
Piston inner spring	95024	1.2040	0.1416	2.7500	7	Steel
Piston outer spring	95027	1.9410	0.2070	3.1560	5	Steel

274—*Q.—How should the parts of the emergency portion be lubricated?* A.—The same as the service portion. The vent-valve piston and accelerated-release piston should be lubricated in the same manner as the main piston.

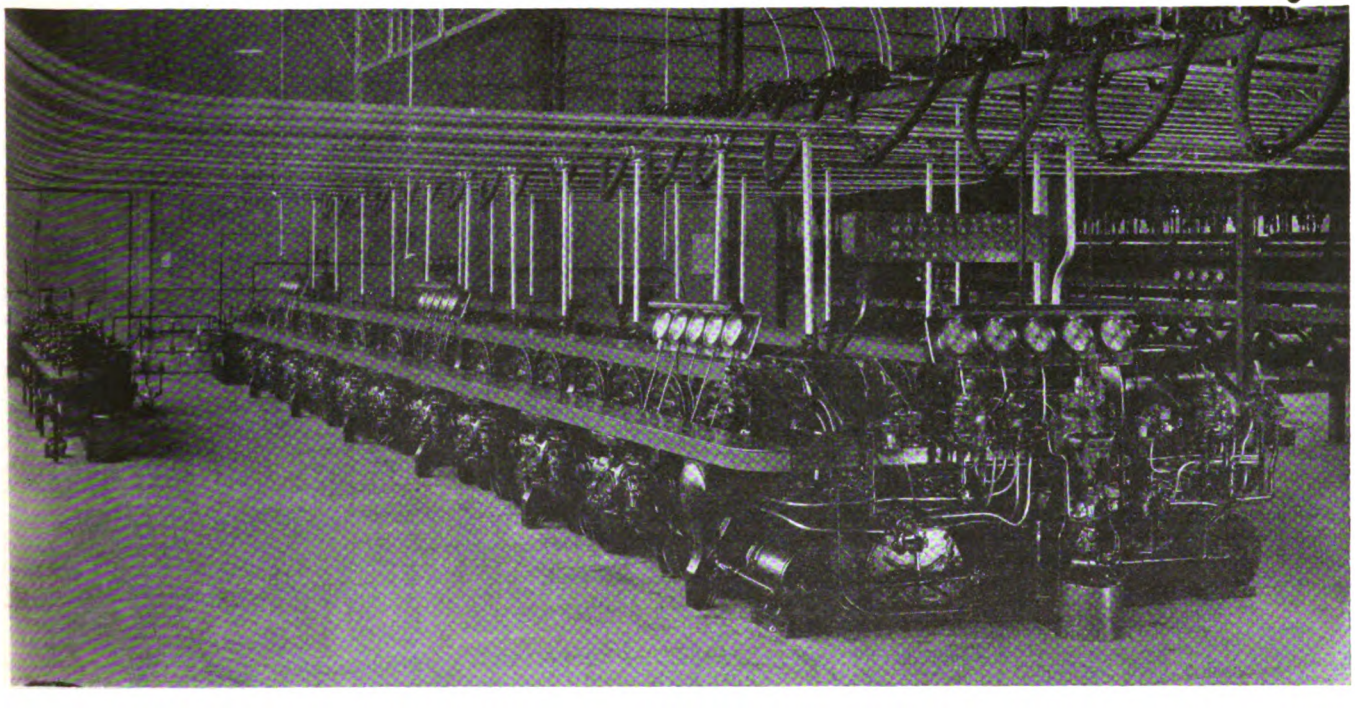
Brake Cylinders

275.—*Q.—How should the brake cylinder be dismantled for cleaning?* A.—It should be dismantled by removing the non-pressure head, thus permitting the removal of the piston assembly.

276—*Q.—How can the cylinder cup be removed?* A.—The cup is not held in place by a follower, but fits over a bead in the piston head; therefore, the removal of the cup is effected by snapping it over the aforementioned bead.

277—*Q.—What attention should be given the packing?* A.—It should be cleaned and inspected carefully. If there are any deep scratches or cracks on the bearing surface or if the packing cup is worn too much to hold a proper bearing, it should be replaced.

* * *



The 20-car UC brake-equipment-test rack of the New York Air Brake Company

At the left front of the rack is the No. 8 distributing valve and, left to right, the No. 6ET automatic and independent brake valves, the L-8-PA pedestal brake valve and the automatic and independent brake valves of the LT equipment. The universal valves are near the floor under the brake cylinders. From the catwalk, angle cocks can be operated and connections made between cars.

Among the Clubs and Associations

Car Department Association of St. Louis Organized

THE Car Department Association of St. Louis has been organized in St. Louis, Mo., to succeed the Car Foremen's Association. Officers elected for the ensuing year are: president, C. R. Wiegman, chief interchange inspector for the St. Louis & East St. Louis Joint Inspection Bureau; first vice-president, W. P. Elliott, general car foreman of the Terminal Railroad Association; second vice-president, F. E. Cheshire, general car inspector of the Missouri Pacific; third vice-president George A. Marx, general car foreman of the Wabash; secretary, J. J. Sheehan, chief clerk to the master car builder of the Missouri Pacific; and treasurer, F. O. Correll, car foreman for the St. Louis Southwestern.

The regular monthly meeting of the association will be held on the third Tuesday of each month at the Statler hotel.

Car Officers' Committees Are Appointed

After a lapse of six years the Car Department Officers' Association held a two-day annual meeting at Chicago last fall, which was sufficiently promising that an attempt is now being made to revive and reorganize the association's activities as a valuable supplement to the work of the A.A.R. Mechanical Division. In line with this objective, President K. F. Nystrom, mechanical assistant to the chief operating officer, Chicago, Milwaukee, St. Paul & Pacific, has recently announced the appointment of the following standing committees with specific duties and personnel as indicated below:

General Committee—To make the association function effectively in improving the knowledge and acquaintance of individual members and promoting greater efficiency in railway car departments:

E. J. Robertson (chairman), superintendent car department, M. St. P. & S. S. M., Minneapolis, Minn.
C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, Chicago.
W. E. Dunham, general superintendent car department, C. & N. W., Chicago.
J. S. Acworth, superintendent of equipment, General American Transportation Corporation, Chicago.
F. L. Kartheiser, chief clerk, mechanical, C. B. & Q., Chicago.
E. L. Woodward, western editor, Railway Mechanical Engineer, Chicago.

Car Construction and Maintenance—To discuss the latest approved A.A.R. recommendations for passenger- and freight-car design and make recommendations for improved methods in connection with car construction and maintenance:

J. McMullen (chairman), superintendent car department, Erie, Cleveland, Ohio.
C. Claudy, master car builder, G. T. W., Battle Creek, Mich.
W. A. Bender, master car builder, Alton, Chicago.
J. S. Acworth, superintendent of equipment, General American Transportation Corporation, Chicago.
J. E. Keegan, chief car inspector, Penna., Chicago.

Shop Operation, Facilities and Tools—To make recommendations for the economical operation of freight- and passenger-car shops, including improved shop facilities, such as buildings, cranes, machinery, etc:

J. A. Deppe (chairman), superintendent car department, C. M. St. P. & P., Milwaukee, Wis.
J. H. Gimpel, assistant superintendent car department, Wabash, Decatur, Ill.
M. F. Covert, general superintendent of equipment, General American Transportation Corporation, Chicago.
H. S. Keppelman, superintendent car department, Reading, Reading, Pa.
P. B. Rogers, shop superintendent, A. T. & S. F., Chicago.

Passenger Train Car Terminal Handling—To make recommendations for the economical operation of passenger-car yards, including car cleaning maintenance of air conditioning equipment, etc:

G. R. Andersen (chairman), district master car builder, C. & N. W., Chicago.
F. E. Cheshire, general car inspector, M. P., St. Louis, Mo.
J. M. Thommen, general car inspector, Penna., Chicago.
C. Houser, general car foreman, N. Y. C., Chicago.
E. J. Hollohan, general car foreman, I. C., Chicago.

Lubricants and Lubrication—To discuss the latest A.A.R. rules covering lubrication and make recommendations for further improvement in the lubrication of freight and passenger cars:

L. R. Wink (chairman), assistant superintendent car department, C. & N. W., Chicago.
F. Maddox, superintendent car department, C. & O., Richmond, Va.
P. P. Barthelemy, master car builder, G. N., St. Paul, Minn.
F. B. Lewis, general car inspector, U. P., Cheyenne, Wyo.
R. Knorr, supervisor car repairs, Erie, Cleveland, Ohio.

Freight Car Inspection for Commodity Loading—To make recommendations for the inspection and selection of cars for commodity loading; cleaning freight cars, eliminating oil spots, odors, etc.:

F. G. Moody (chairman), master car builder, N. P., St. Paul, Minn.
F. J. Swanson, general car department supervisor, C. M. St. P. & P., St. Paul, Minn.
E. S. Smith, master car builder, F. E. C., St. Augustine, Fla.
P. J. Hogan, supervisor car inspection, N. Y. N. H. & H., New Haven, Conn.
W. A. Emerson, master car builder, E. J. & E., Joliet, Ill.

Interchange Rules—To report on car inspection and interchange problems, reviewing the latest rule changes approved by the A.A.R. and recommending desirable further revisions:

M. R. Fitzgerald (chairman), general car inspector, C. & E. I., Danville, Ill.
C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, Chicago.
J. E. Mehan, assistant to superintendent car department, C. M. St. P. & P., Milwaukee, Wis.
H. E. Wagner, general car foreman, M. P., Dupe, Ill.
C. Houser, general car foreman, N. Y. C., Chicago.

Loading Rules—To discuss the latest approved changes in A.A.R. loading rules and make recommendations for loading methods and other details essential to better service:

C. J. Nelson (chairman), superintendent of interchange, Chicago Car Interchange Bureau, Chicago.
G. R. Andersen, district master car builder, C. & N. W., Chicago.
H. H. Golden, supervisor, A. A. R. Interchange and Accounting, L. & N., Louisville, Ky.
H. T. DeVore, chief int. inspector, Youngstown Car Inspection Association, Youngstown, Ohio.
Wm. Govert, master car builder, E. J. & E., Cary, Ind.

Car Repair Billing—To analyze the latest approved changes in A.A.R. billing rules and make recommendations for further improvements in these rules:

D. E. Bell (chairman), A. A. R. instructor, C. N., Winnipeg, Man.
B. J. Jamison, assistant supervisor car insp., Southern, Birmingham, Ala.
E. S. Swift, chief A. A. R. clerk, Wabash, Decatur, Ill.
W. E. Henley, traveling mechanical inspector, I. C., Chicago.
W. J. Burns, mechanical inspector, General American Transportation Corporation, Chicago. American Transportation Corporation, Chicago.

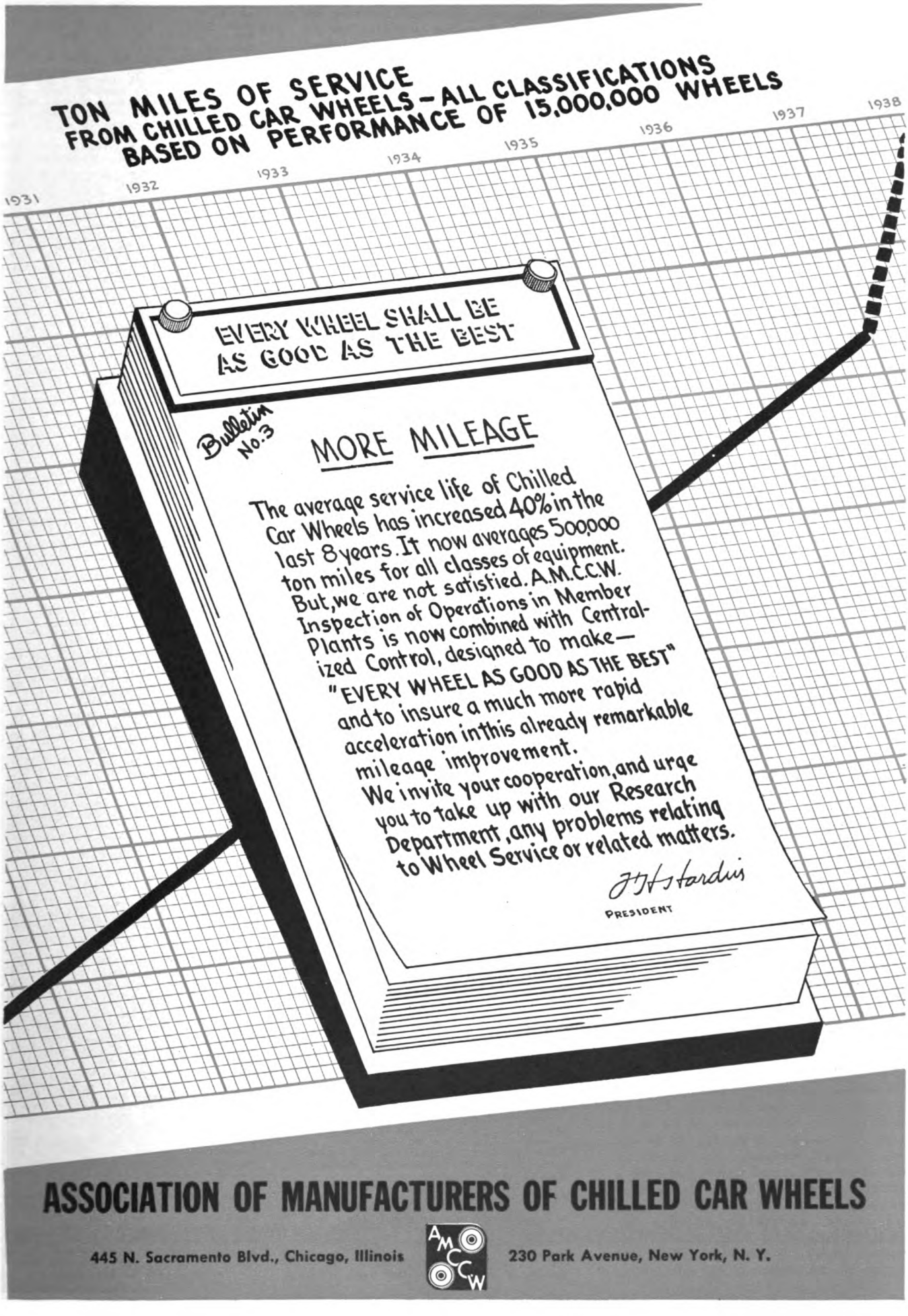
Equipment Painting—To study general painting problems and report on improved methods of painting freight- and passenger-car equipment:

L. B. Jenson (chairman), passenger shop superintendent, C. M. St. P. & P., Milwaukee, Wis.
M. Thierry, foreman painter, N. & W., Roanoke, Va.
D. C. Sherwood, foreman painter, N. Y. C., West Albany, N. Y.
C. E. Bergquist, foreman car painter, C. & N. W., Chicago.
J. F. Monger, shop superintendent, I. C., Chicago.
R. B. Batcheler, foreman car painter, Wabash, Decatur, Ill.
J. McDowell, foreman paint shop, C. R. I. & P., Chicago.
W. Schwenk, foreman painter, M. P., Sedalia, Mo.
C. Swing, painter foreman, Pullman-Standard Car Manufacturing Company, Chicago.
D. Richmann, paint foreman, Pullman Company, Chicago.
M. P. Neuberger, foreman painter, M. St. P. & S. S. M., Shoreham, Minn.
Robert Woods, master painter, G. T. W., Port Huron, Mich.
W. Adolf, master painter, U. P., Omaha, Neb.
J. Pritchard, master painter, A. T. & S. F., Topeka, Kan.

Western Metal Congress

The Western Sections of a number of national technical societies, including the American Society of Mechanical Engineers, the American Welding Society and the American Society for Testing Materials, are co-operating in the Western Metal Congress and Western Metal Exposition to be held at Los Angeles, Calif., March 21, 22, 23, 24 and 25. At a session on Monday morning, March 21, at the Hotel Biltmore, "The Fabrication and Application of Stainless Steels Containing 18 Per Cent Chromium and Over" will be discussed by Dr. V. N. Krivobok, associate director of research, Allegheny Steel Company, Brackenridge, Pa. In the afternoon, at the Pan-Pacific Auditorium, A. F. Stuebing, railroad mechanical engineer, United States Steel Corporation, New York, will present a paper on "High-Tensile Structural Steels

(*Continued on next left-hand page*)


TON MILES OF SERVICE
FROM CHILLED CAR WHEELS—ALL CLASSIFICATIONS
BASED ON PERFORMANCE OF 15,000,000 WHEELS
1931
1932
1933
1934
1935
1936
1937
1938
EVERY WHEEL SHALL BE
AS GOOD AS THE BEST
Bulletin No. 3
MORE MILEAGE
The average service life of Chilled Car Wheels has increased 40% in the last 8 years. It now averages 500,000 ton miles for all classes of equipment. But, we are not satisfied. A.M.C.C.W. Inspection of Operations in Member Plants is now combined with Centralized Control, designed to make—
"EVERY WHEEL AS GOOD AS THE BEST"
and to insure a much more rapid acceleration in this already remarkable mileage improvement.
We invite your cooperation, and urge you to take up with our Research Department, any problems relating to Wheel Service or related matters.
J. H. Hardis
PRESIDENT
ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS
445 N. Sacramento Blvd., Chicago, Illinois
A M C C W
230 Park Avenue, New York, N. Y.

Metal Congress (Continued)

in Transportation." On Thursday morning, March 24, at the Biltmore Hotel, two other papers of interest to the railroad industry will be presented by J. P. Gill, chief metallurgist, Vanadium Alloys Steel Corp., Latrobe, Pa.: "Carbon and Low-Alloy Tool Steels" and "High Speed and Highly Alloyed Tool Steels."

A series of five educational lectures under the title "Fundamentals of Ferrous Metallurgy" will be given at evening sessions at the Pan-Pacific Auditorium by Dr. A. Allan Bates, manager of the chemical and metallurgical department, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Club Papers

Railroad Labor Relations Today

NEW YORK RAILROAD CLUB.—Meeting held at New York, February 18, 1938. Otto S. Beyer, chairman of the National Mediation Board, discussed the opportunity which railroad labor has to exercise a constructive influence on the future progress of the railroad industry. ¶"We all realize," said Mr. Beyer, "that the railroads are now confronted with problems whose solution challenges the resourcefulness and statesmanship of both our managers and employees . . . It is clear that unless ways are found to co-operate with them [employees] constructively, railroad service stands to suffer and railroad employment to decline." ¶Mr. Beyer devoted a considerable part of his address to emphasizing the possibilities for better organized co-operation between the employees and the managements in fields beyond the direct performance of duties for which the employees are paid. ¶Railroad employees, he said, are in an exceptional position to determine how the myriad detailed processes of operation can best be performed and to devise new and better ways of doing them. "Given a genuine inducement to improve these processes," said Mr. Beyer, "an army of a million and a quarter individuals is available to make innumerable contributions by way of bettering the day-by-day performance of our railroads." He also pointed out the strategic position of railroad employees with respect to the public relations of the industry. The value of the joint-conference method of relations between labor and management to matters of common interest other than purely labor questions, Mr. Beyer thought, would develop only if the employees have the same freedom in the choice of representatives established by the Railway Labor Act for the purposes of collective bargaining.

Usefulness, The Supreme Test

CENTRAL RAILWAY CLUB.—In an address before the Central Railway Club of Buffalo, N. Y., on February 10, Dr. C. S. Duncan, economist, Association of American Railroads, introduced his remarks by the statement that two factors had made a profound impression; namely, the essential necessity for an adequate, efficient transport system and the overwhelming efficiency of railroads as compared with competitive forms of transport. He paid tribute to the ability of the railroads to carry on efficiently, under regulation, in competition with subsidized carriers, not so regulated. ¶Looking somewhat into the future, Mr. Duncan raised the questions as to what tests must ultimately determine the relative importance to public welfare of the various transport agencies, and upon what basis are we to determine what agencies are to be maintained and what ones are to be neglected? He said that the correct answer to these inquiries will provide the basis for a sound national transportation policy. In developing his remarks, Mr. Duncan mentioned certain methods that have been used to measure the relative usefulness of transport agencies: First, The historical method which, in essence, means that which is newest is best. Second, the relative traffic method, meaning that the agency carrying the greatest number of units is the most useful. Third, the relative tariff charge for service. This method is based on the theory that the lower the direct charge the more superior the agency. Fourth, the cost and service test. Fifth, the "full community service" method, based upon a theory that the true measure of relative usefulness of a transport facility is its ability to afford complete service to the whole needs of a community or the entire country. ¶In concluding his remarks Mr. Duncan said, in part, "I care not what test is applied, or with what weight attached, if all agencies must meet them on an even-handed basis. The community that can support every known means of transportation is unquestionably entitled to them all," provided it does support them and does not pass a part of the cost on to the public in the form of taxes. ¶If this primary principle were adopted, I think everything else would follow simply, logically and inevitably. Any test of relative usefulness for any agency will require careful consideration for all. We have never had that heretofore.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—R. P. Ives, Westinghouse Air Brake Company, 350 Fifth avenue, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION.—J. F. Gettrust, 1108 New Post Office Bldg., Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—C. E. Davies, 29 West Thirty-ninth street, New York.

RAILROAD DIVISION.—Marion B. Richardson, P. O. Box 205, Livingston, N. J.

MACHINE SHOP PRACTICE DIVISION.—J. R. Weaver, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

MATERIALS HANDLING DIVISION.—F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

OIL AND GAS POWER DIVISION.—M. J. Reed, 2 West Forty-fifth street, New York.

FUELS DIVISION.—A. R. Mumford, N. Y. Steam Corp., 130 E. Fifteenth st., New York.

ASSOCIATION OF AMERICAN RAILROADS.—J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

OPERATING SECTION.—J. C. Caviston, 30 Vesey street, New York.

MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

COMMITTEE ON RESEARCH.—William J. Cantley, mechanical engineer Lehigh Valley, Bethlehem, Pa.

PURCHASES AND STORES DIVISION.—W. J. Farrell, 30 Vesey street, New York.

MOTOR TRANSPORT DIVISION—George M. Campbell, Transportation Building, Washington, D. C.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, Statler Hotel, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p. m.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—F. T. James (President), general foreman, D. L. & W., Kingsland, N. J.

INTERNATIONAL RAILWAY MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

MASTER BOILER MAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September, at Hotel Touraine, Boston.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July, August and September, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, University and Prior avenue, St. Paul.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francsico, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Calif., alternately—June in Los Angeles and October in Sacramento.

RAILWAY CLUB OF GREENVILLE.—J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FIRE PROTECTION ASSOCIATION.—P. A. Bissell, 40 Broad street, Boston, Mass.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, 1255 Old Colony building, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

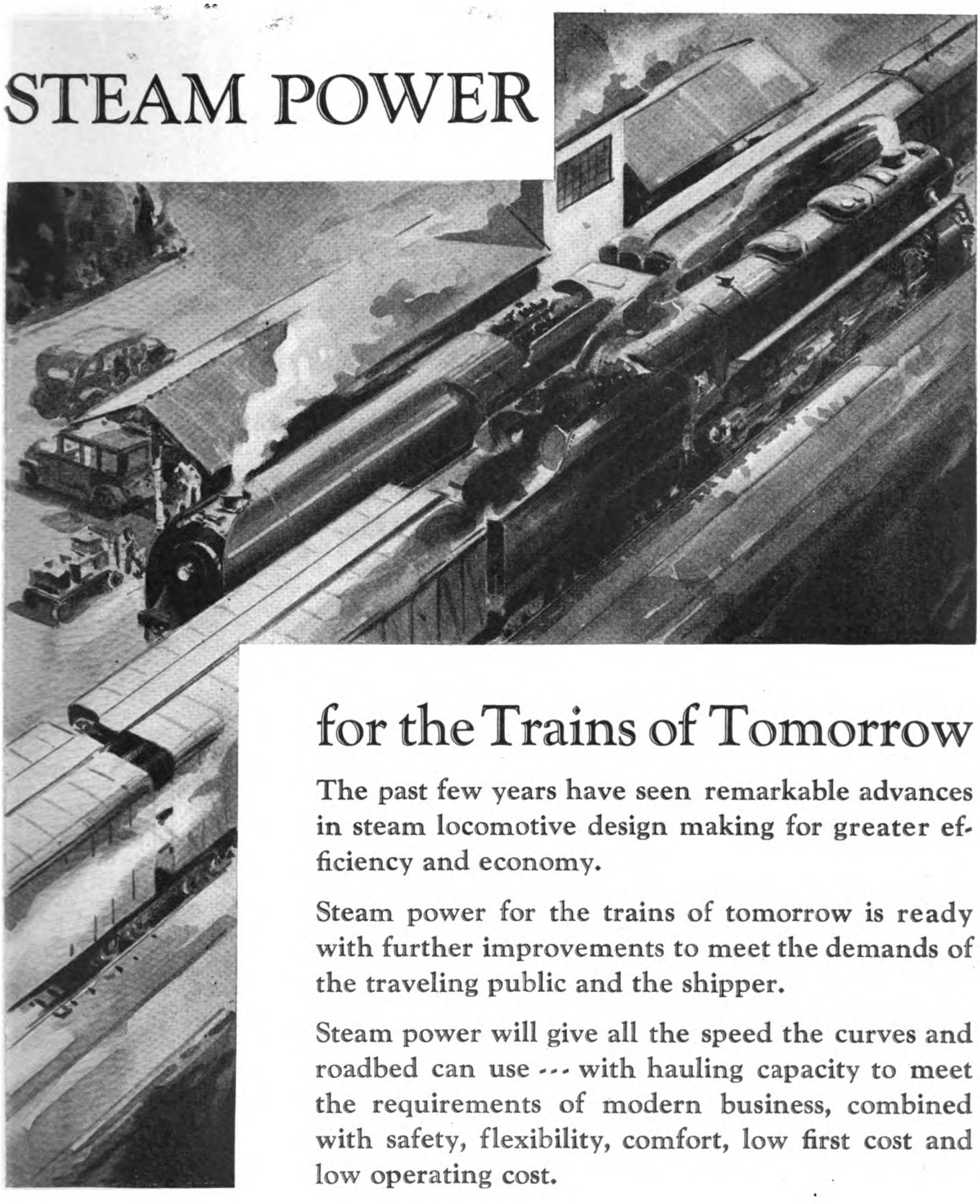
TORONTO RAILWAY CLUB.—D. M. George, Box S, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

TRAVELING ENGINEERS' ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

WESTERN RAILWAY CLUB.—C. L. Emerson, executive secretary, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, Aug. and Sept.

(Turn to next left-hand page)

STEAM POWER



for the Trains of Tomorrow

The past few years have seen remarkable advances in steam locomotive design making for greater efficiency and economy.

Steam power for the trains of tomorrow is ready with further improvements to meet the demands of the traveling public and the shipper.

Steam power will give all the speed the curves and roadbed can use --- with hauling capacity to meet the requirements of modern business, combined with safety, flexibility, comfort, low first cost and low operating cost.

LIMA LOCOMOTIVE WORKS LIMA LOCOMOTIVE WORKS INCORPORATED INCORPORATED, LIMA, OHIO



Henschel steam switching locomotive of the Besler type—Weight, 37,250 lb.; boiler pressure, 1,140 lb.; steam temperature, about 700 deg.; maximum speed, 37 m.p.h.

NEWS

Train-Handling Conference

THE Kansas State Board for Vocational Education is planning a train-handling and locomotive-devices conference, to be held in the Chamber of Commerce Building, Kansas City, Kan., March 29 to April 1, inclusive. The conference leader will be C. M. Drennan, Kansas State Teachers College, Pittsburgh, Kan.

G. E. Puts Turbo-Electric Unit Through Its Paces

THE General Electric Company, which is building a twin-unit steam-electric locomotive, powered primarily by two oil-fired 2,500-hp. "steamotive" units, for service on the Union Pacific, has for some weeks been carrying on track tests with one completed unit at its Erie, Pa. plant.

Equipment Depreciation Orders

THE Interstate Commerce Commission has issued additional sub-orders and modifications of previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies, prescribing depreciation rates for equipment of eight roads, including the Chesapeake & Ohio, the Bessemer & Lake Erie and the Chicago & North Western. The composite percentages, which are not prescribed rates, range from 2.71 per cent for the State Belt of California to 5.72 per cent for the Wyoming.

The C. & O. composite percentage of 4.29 is derived from the following prescribed rates: Steam locomotives, 3.82 per cent; freight-train cars, 4.52 per cent; passenger-train cars, 3.21 per cent; floating equipment, 3.25 per cent; work equipment, 4.67 per cent; miscellaneous equipment, 17.56 per cent. The B. & L. E.'s 3.36 per cent composite figure comes from prescribed rates as follows: Steam locomotives (owned), 4.05 per cent; steam locomotives (leased), 3.09 per cent; other locomotives 4.8 per cent; freight-train cars (owned), 3.19 per cent; freight-train cars (leased), 3.06 per cent; passenger-train cars, 3.5 per cent; work equipment (owned), 3.78 per cent; work equipment (leased), 2.77 per cent; miscellaneous equipment, 14.75 per cent. The sub-order, which modifies a previous one with respect to the C. & N. W., was issued to provide separate rates for equipment in streamlined trains as follows: Locomotives other than steam, 6.4 per cent; passenger-train cars, 6.4 per cent.

Proposed Changes in Explosives Rules Issued

THE Bureau of Explosives of the Interstate Commerce Commission has issued a first proof of its proposed general revision of I. C. C. regulations for the transportation of explosives and other dangerous articles by freight and specifications for shipping containers. In a preface signed by W. S. Topping, chief inspector of the bureau, it is stated that the general revision includes re-arrangement of the rules, elimination of duplication of rules, and a simplification of shipping requirements.

Mr. Topping requests that prompt consideration of the revision be given by interested parties and asks that additions, changes or modifications be submitted to the Bureau of Explosives, 30 Vesey Street, New York, on or before March 15.

Unit Fuel Costs Increase

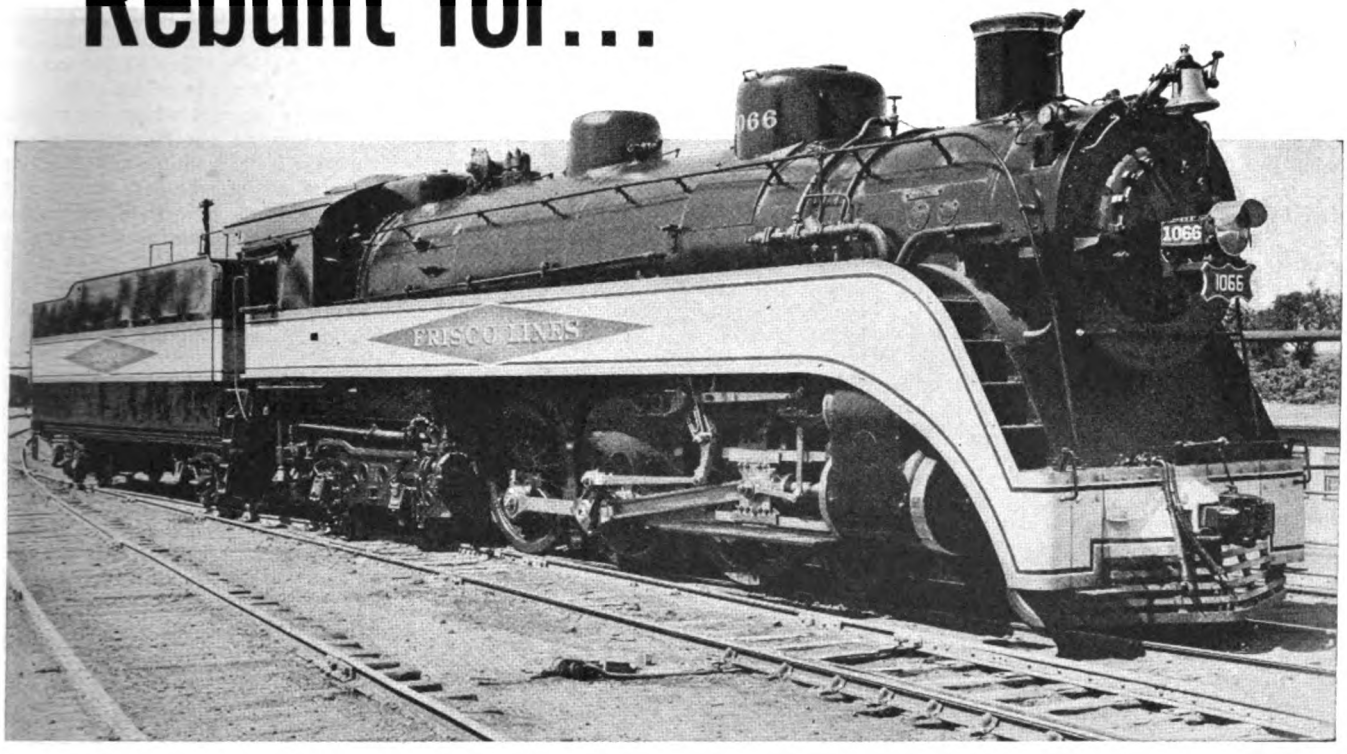
IN an effort to concentrate attention on rising fuel costs and the necessity of redoubled efforts to conserve fuel, the Railway Fuel & Traveling Engineers' Association has developed the table of comparative performances and costs given below, based on figures compiled by the Interstate Commerce Commission Bureau of Statistics. The figures are for freight

(*Continued on next left-hand page*)

Fuel Performances and Costs in Freight and Passenger Road Service, Class I Railways

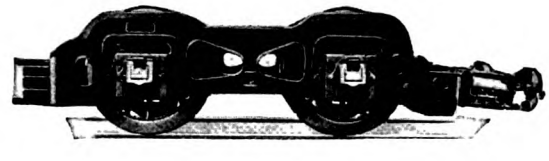
	December 1937	December 1936	Per cent increase or decrease, 1937, compared with 1936
Coal per 1,000 gross ton-miles, lb. (Including locomotive and tender)	128.0	127.0	+0.79
Fuel cost per 1,000 gross ton-miles, cents (Including locomotive and tender)	17.80	16.40	+8.54
Coal per passenger train car-miles, lb.	16.0	15.9	+0.63
Fuel cost per passenger train car-mile, cents	2.22	2.03	+9.36
Average cost of fuel per equated net ton (Coal equivalent)	$2.78	$2.58	+7.75
	1937 Year	1936 Year	
Coal per 1,000 gross ton-miles, lb. (Including locomotive and tender)	117.0	119.0	−1.68
Fuel cost per 1,000 gross ton-miles, cents (Including locomotive and tender)	15.85	15.47	+2.46
Coal per passenger train car-mile, lb.	15.1	15.3	−1.31
Fuel cost per passenger train car-mile, cents	2.04	1.98	+3.03
Average cost of fuel per equated net ton (Coal equivalent)	$2.72	$2.59	+5.02

Rebuilt for...



...MODERN RAILROADING

The five Frisco locomotives converted from 4-6-2 type to 4-6-4 type and modernized by the application of capacity-increasing, fuel-saving devices of proved merit are splendid examples of what can be accomplished with existing power. » » » As modernized, these oil-burning locomotives are equipped with the Franklin Locomotive Booster, Franklin Power Reverse Gear, Franklin Type E-2 Radial Buffer, and Franklin Sleeve Joints between engine and tender. » » » With the main cylinders developing 47,800 pounds tractive effort, the Booster provides an additional tractive effort of 11,500 pounds for starting, accelerating, and for speeds up to 18 miles per hour over the ruling grade. » » » As modernized, this power has high capacity needed for starting, for rapid acceleration to road speeds and for handling trains over the ruling grade. » » » This factor together with high capacity at high road speeds enables it to handle successfully and economically modern high-speed passenger trains with pleasing results that increase the good-will.



No locomotive device is better than the replacement part used for maintenance.
Genuine Franklin repair parts assure accuracy of fit and reliability of performance.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

and passenger road service on Class I carrier (excluding switching and terminal companies) and show an increase of 8.54 per cent in fuel cost per 1,000 gross ton-miles and 9.36 per cent per passenger train car-mile in December, 1937, as compared with December, 1936. Figures are also given for the year 1937, as compared with 1936, and show that in spite of decreased unit fuel consumption in both freight and passenger service, unit fuel costs have increased 2.46 and 3.03 per cent, respectively.

According to a carefully-developed estimate, the present minimum prices for locomotive coal prescribed by the National Bituminous Coal Commission will increase the railroad fuel bill for 1938 to the extent of $21,000,000 above the amount of approximately $275,000,000 spent in 1937, or an increase of 7.6 per cent.

Improvement Programs

LEHIGH VALLEY.—The Lehigh Valley has asked the Interstate Commerce Commission for permission to borrow $778,000 from the Reconstruction Finance Corporation for repairs and for the purchase of new rolling stock. The company needs to repair 1,460 steel coal cars and would re-employ 300 men to carry out this work at its Sayre, Pa., and Packerton shops.

CHICAGO & NORTH WESTERN.—The C. & N. W. is considering re-equipping its "400" (which operates between Chicago and the Twin Cities) with lightweight, streamline equipment. Inquiries have been issued for 12 passenger cars and three locomotives. The request for bids covers conventional steam locomotives, Diesel-electric locomotives, and steam turbine-electric locomotives and lightweight cars.

CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC.—The district court at Chicago has authorized trustees of the C. M. St. P. & P. to seek Interstate Commerce Commission permission to issue $2,235,000 in equipment trust certificates to finance $3,210,922 of new equipment. The equipment includes four high-speed steam locomotives, 55 passenger cars and 464 fifty-ton flat cars, the car equipment to be constructed in company shops when the present program of building 1,000 gondola cars is completed in April. Some of the new passenger cars will be used to equip additional sections of the Hiawatha, while others will be used to replace obsolete equipment. On December 31, 1935, according to the petition, the road had 958 passenger cars with an average age of 25 years. The petition indicated that the road plans to use the new locomotives on runs between Chicago and the Twin Cities because locomotives now operating between these cities are required to run at higher speed than they were designed to make.

UNION PACIFIC.—Resumption of a $9,000,000 car-building program has been announced by W. M. Jeffers, president of the Union Pacific, on February 16. In making the announcement Mr. Jeffers said "recessions do not last forever. While our revenues have shown a drastic decline during the past ninety days and the outlook for the near future is not favorable, we have decided to disregard the immediate situation and to continue our program in anticipation of future improvement in business conditions . . . During the past two years we have carried on this car-building program in our own shops in the West employing our own skilled labor in order to stabilize just as far as practicable employment conditions on our lines."

Construction of 2,600 cars under an appropriation of $9,000,000 was begun in October, 1937, and of this number 1,700 cars remain to be completed. Resumption of construction will provide employment till next summer for the 400 employees who have just recently returned to work at the Omaha, Neb., Grand Island and Portland, Ore., shops.

MISSOURI PACIFIC.—The expenditure of $7,621,153 for improvement to right-of-way and rolling stock of the Missouri Pacific and six subsidiaries has been authorized by the federal district court at St. Louis. Of this amount, $7,008,973 will be expended on Missouri Pacific property. Of the latter amount $1,118,040 is for equipment and shop improvement. Among the improvements included in the schedule are those at the enginehouse and shops in St. Louis to cost $103,840, the construction of bridges, grade crossings, stations and shop and the repair of locomotives, passenger and freight cars.

In addition to this amount, the district court later approved a budget of $1,769,660 for improvements this year on the lines of the International-Great Northern and the New Orleans, Texas & Mexico.

NEW YORK, NEW HAVEN & HARTFORD.—The New Haven has received permission of the United States District Court to remodel into modern coaches 50 cars formerly used on the New York, Westchester & Boston, at a total cost of $700,000 and the overhauling and modernizing of 100 of the New Haven's old standard steel coaches at a cost of $553,000.

Electrical equipment which was required for operation of the Westchester cars, which are of the multiple-unit type, will be removed, the center doors will be taken out and replaced with wall sections and windows, sliding end-doors will be changed to swinging doors, baggage racks will be installed, the cars will be equipped with a modern steam-heating system, and they will be furnished with the latest type of comfortable seats.

The 100 standard steel cars also will have all the old type seats replaced with present-day more comfortable seats, and modern lighting, new steam piping with thermostatic heat control, and new floors will be installed.

These remodelled cars will be in addition to the 50 new streamline coaches which the court has authorized and which will bring to a total of 200 the number of that type of coach owned by the New Haven.

The court has also authorized the purchase of 10 Diesel-electric switching locomotives.

Transport Equipment Obtained Through P. W. A.

CLOSE to $100,000,000 worth of new transportation equipment is in use throughout the nation as the result of the Public

(*Continued on next left hand page*)

New Equipment Orders and Inquiries Announced Since the Closing of the February Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
Grand Trunk Western	6	4-8-4 streamline	Lima Locomotive Works
Maine Central	1*	250-hp. gas-mech.	Plymouth Locomotive Works
New York, New Haven & Hartford	10	600-hp. Diesel-electric	American Locomotive Co.

LOCOMOTIVE INQUIRIES

Chicago & North Western	..	Steam
	..	Diesel-electric
	..	Steam-turbine
	..	Turbine mechanical

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Canadian National	700	Box	Eastern Car Co.
	700	Box	Nat'l Steel Car Corp.
	600	Box	Canadian Car & Fdry. Co
Chicago, Burlington & Quincy	100	Rodger ballast	American Car and Foundry Co.
Paulista Railway of Brazil	125	Gondola	Pullman-Standard Car Export Corporation
	125	Flat	
	95	Underframes	

FREIGHT-CAR INQUIRIES

Bangor & Aroostook	500	40-ton box
	100	70-ton hopper
	50	50-ton rack

PASSENGER-CAR ORDERS

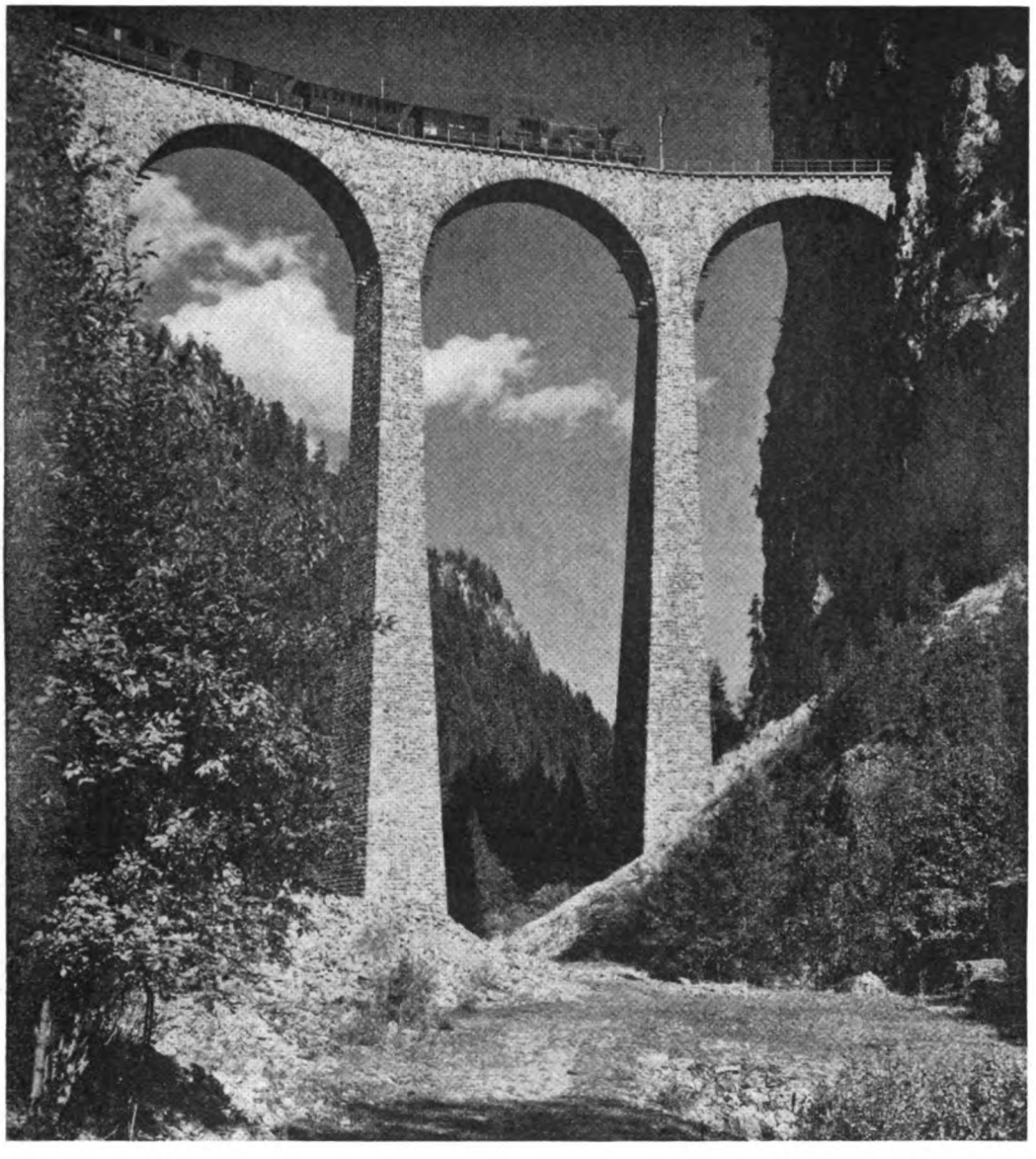
Canadian National	6†	Dining	Canadian Car and Foundry Co., Ltd.
	10†	Cafe-sleeper	
New York, New Haven & Hartford	50‡	Lightweight	Pullman-Standard Car Manufacturing Co.

* M-L-8 type, 30-ton locomotive with 8 cylinders, 6¾ in. by 7 in., equipped with a LeRoy engine, for service at Lewiston, Me.

† All of the cars are to be air-conditioned and, it is expected, will be delivered next June. The cafe-sleeping cars, designed by the company's engineers and architects, are a departure from the usual type of equipment. Each car will consist of 8 sections, a double bedroom, smoking room and ladies' dressing room, with a cafe at one end accommodating 16 guests. The kitchen and pantry of the dining cars will be somewhat smaller than the regulation diner; they will each have accommodation for 40 persons, which is 4 more than those now in use, and will be 20,000 lb. lighter than the old type, being constructed of alloy steel.

‡ The court has granted permission to this road to rebuild 100 of its own coaches and 50 of the coaches formerly used on the New York, Westchester and Boston.

NO. 12 OF A SERIES OF FAMOUS ARCHES OF THE WORLD



LANDWASSER VIADUCT, SWITZERLAND

The Landwasser Viaduct, on the Rhaetian Railway, Switzerland, is one of the most unique railway viaducts, being built on a curve of 328 feet radius. Another unusual feature is that the viaduct springs from a precipice, at which point the railroad enters a tunnel. » » » Each of its six arches spans a distance of 60 feet; the total length of the viaduct is 426 feet. The Landwasser Viaduct carries the main-line of the Rhaetian Railway from Coire to St. Moritz and the Engadine Valley.

* * *

The Security Sectional Brick Arch for the Locomotive firebox is the first major step in reducing fuel costs. It has had an important influence in the improved design of the modern locomotive firebox and is essential to the successful operation of larger modern power.

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

Works Administration program, a report of the Bureau of Labor Statistics shows.

"The equipment," the report says, "ranges from motorcycles to freight cars, and embraces transportation for land, water and air."

Total purchases of transportation equipment financed by the P. W. A. were put at $90,032,332. Railway equipment purchases were thus financed "in an effort to revive employment in railroad equipment lines. As a result, out of the total of $1,708,685,535 spent for materials throughout the whole P. W. A. construction program, $38,839,968 went for railway freight cars. Passenger cars to the extent of $8,893,300 were purchased and $18,671,303 was spent for locomotives."

Equipment Installed in 1937

CLASS I railroads in 1937 installed 75,058 new freight cars in service, according to the Association of American Railroads. At the same time, reports showed a sharp drop in the number of new freight cars on order on January 1.

The number of new freight cars installed in 1937 was the largest number placed in service in any one year since 1930, "owing to the large orders for new equipment which were awarded early in 1937 in anticipation of heavy freight traffic." The decrease in such orders in the latter months of the year is attributed to "the financial condition of the railroads and the reduction in traffic that took place."

The 1937 freight car installations represent an increase of 31,117 compared with 1936 and an increase of 66,155 compared with 1935. The 1937 total included 37,663 cars, 30,022 box cars, 4,227 refrigerator cars, 1,993 flat cars, 712 stock cars and 441 miscellaneous cars.

Class I roads also put in service 373 new steam locomotives in 1937, also the greatest number for any year since 1930. In 1936 new steam locomotives put in service totaled 87 and in 1935, 40; new electric and Diesel locomotives totaled 77 compared with 34 in 1936 and 102 in 1935.

New freight cars on order on January 1 totaled 7,947 compared with 12,566 on December 1, 1937, and 25,592 on January 1, 1937. New steam locomotives on order on January 1, totaled 131 compared with 156 on December 1, 1937, and 297 on January 1, 1937. New electric and Diesel locomotives on order at the beginning of this year totaled 30 contrasted with 40 ordered on December 1, last, and seven orders on hand at the beginning of 1937.

New freight cars and locomotives leased or otherwise acquired are not included in the above figures.

"Soda Ash Johnny" Passes Away

JOHN M. HORAN of the Chicago, Milwaukee, St. Paul & Pacific, who died on Friday, February 4, at the age of 100 years and 12 days, has established a record for continuous service with a railroad which it will be difficult to reach or surpass. He remained in service until his death, and on the occasion of his one-hundredth birthday, January 23, 1938, was given a party in a dining car in the Milwaukee shops, the accompanying photograph having been taken on that day.



John M. Horan on his one-hundredth birthday

Mr. Horan, or "Soda Ash Johnny" as he was more familiarly called, was born in Burlington, Vt., January 23, 1838, but grew up from childhood in Milwaukee. He entered the service of the Milwaukee & Mississippi Railroad, April 17, 1855. Wood was used for locomotive fuel and his first job was to pile the prepared wood in racks with capacities of one-quarter cord, one-half cord, and one cord, this being the means of measuring the amount of fuel issued to the locomotives. He was ambitious to become a mechanic and served a machinist apprenticeship on the Milwaukee & Prairie du Chien Railroad, the successor to the Milwaukee & Mississippi. Later he became a locomotive fireman and then was promoted to engineer. When the Dakota Southern Railroad was purchased by the Chicago, Milwaukee & St. Paul, Mr. Horan was sent to Yankton, S. D., as general foreman. Water conditions in that territory were bad and Mr. Horan was unusually successful in developing a treatment of the water used in locomotive boilers. Because of this he was assigned to follow up boiler feedwater conditions and the washing and care of boilers on the entire system, and was active in that occupation until his death.

Union Pacific Locomotives—A Correction

LEWIS special staybolt iron, furnished by Joseph T. Ryerson & Son, Inc., Chicago, was used for the flexible and rigid stays on six and five locomotives, respectively, of the 4-8-4 type recently delivered to the Union Pacific by the American Locomotive Company. The Lewis Bolt & Nut Co. is incorrectly given in the list of materials on page 49 of the February issue.

Supply Trade Notes

THE THOMAS GRATE BAR COMPANY, Birmingham, Ala., has changed its name to Thomas Foundries, Inc.

◆

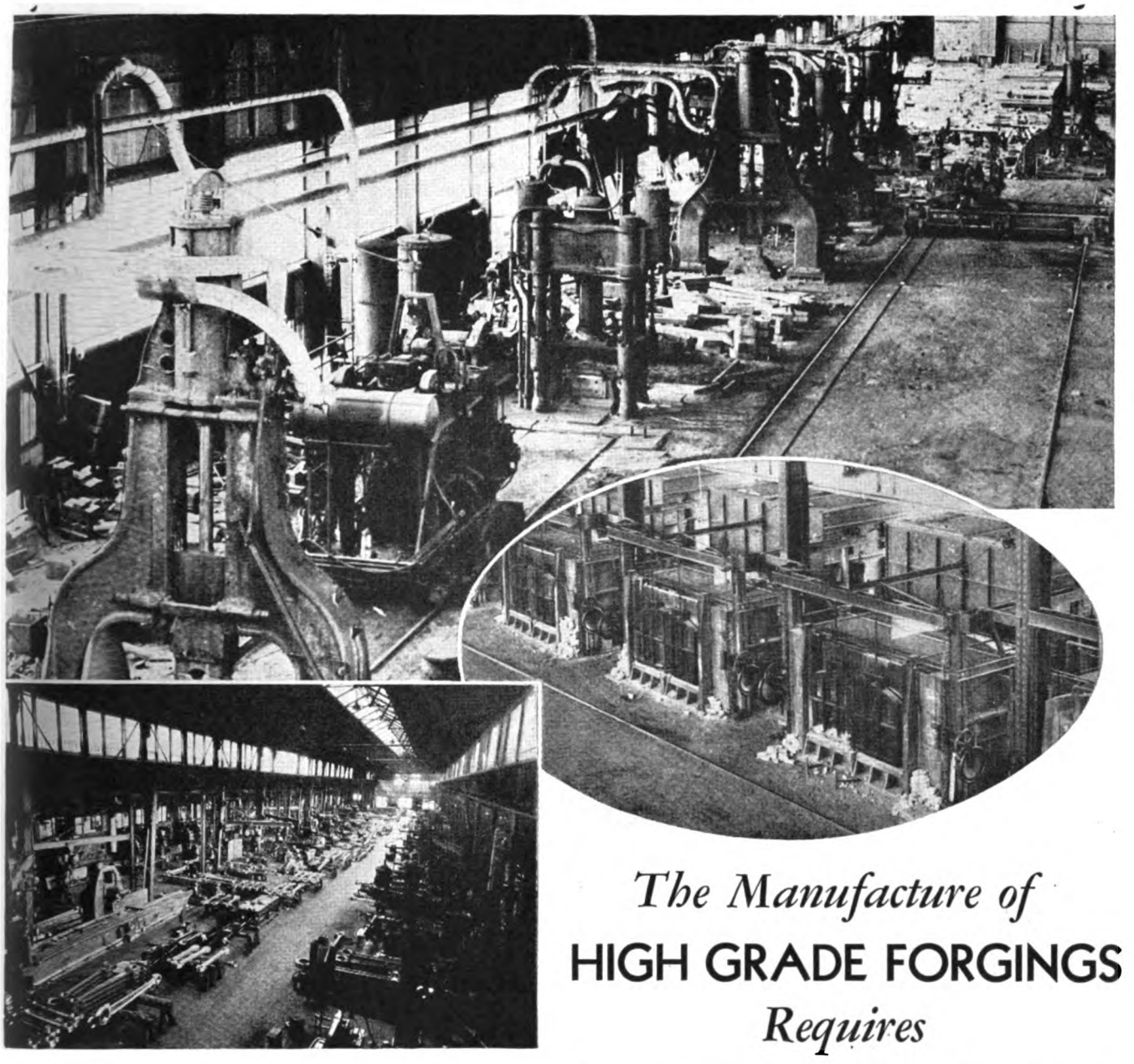
GEORGE KIRTLEY, assistant to the vice-president of the Plymouth Locomotive Works, division of The Fate-Root-Heath Company, Plymouth, Ohio, has been appointed sales manager of the Locomotive Division, and Roy J. Johnson, assistant chief engineer, has been appointed assistant sales manager.

J. R. FRAINE has been appointed assistant manager of sales of the Republic Steel Corporation, wire division for the northern territory, with headquarters at Chicago. Carl C. Brown, district sales manager at Birmingham, Ala., has been appointed assistant manager of sales of the wire division, at Birmingham.

◆

C. D. CAREY, who has been handling railway sales for the Gulf Oil Corporation and its subsidiary the Gulf Refining Company, Pittsburgh, Pa., has been appointed manager of railway sales for both companies, with headquarters at Pittsburgh. Mr. Carey is a graduate of Princeton University and Massachusetts Institute of Technology. He gained his first railway experience while working under Dr. P. H. Dudley, consulting engineer of the New York Central lines and while employed in the metallurgical and railway sales department of the Bethlehem Steel Company. Later he served as associate

(*Continued on next left-hand page*)



The Manufacture of

HIGH GRADE FORGINGS

Requires

LARGE CAPITAL INVESTMENTS

THERE should be little or no need for any railway to make large capital investments in shops, modern equipment and new precision machinery to manufacture forgings.

Because—First, if a railroad should make any such investment their manufacturing unit costs would be prohibitively high because output would be relatively low.

Secondly, such capital investments are unnecessary because Alco shops which are manned by a thoroughly experienced personnel are already fully equipped, always kept at top-notch efficiency throughout, modern in every respect with sufficient output to keep costs relatively low.

As a result Alco's complete forging service not only assures the highest quality forgings but enables railroads to use available capital for more productive purposes.

AMERICAN LOCOMOTIVE COMPANY

30 CHURCH STREET·NEW YORK·N·Y

engineer physicist, investigating the causes of rail failures for the U. S. Bureau of Standards. For several years he was assistant to the president of the Standard



C. D. Carey

Motor Truck Company and the Verona Steel Castings Company, subsidiaries of the Standard Steel Car Company. During the war he was in charge of the Pittsburgh district for the R. W. Hunt Company.

◆

J. C. McCUNE, assistant director of engineering of the Westinghouse Air Brake Company, has been appointed to the newly-created position of director of research, with headquarters at Wilmerding, Pa. Mr. McCune was graduated from Cornell University in mechanical engineering in 1911. He entered the employ of the Westinghouse Air Brake Company in 1913, as assistant to the chief engineer and, after two years, was transferred to the New York office as mechanical expert, which position he held from 1915 to 1917. He then served on the Mexican border with



J. C. McCune

the seventh regiment New York National Guards, and later in the World War as first lieutenant of engineers of the United States Army, with 10 months' service in France. At the conclusion of the war, he returned to the Westinghouse Air Brake Company as a special engineer at Wilmerding. In 1920 he returned to the New York office as assistant to the district engineer, and a few months later was made assistant district engineer. In 1922 he was promoted to the position of district engineer. A further promotion came in 1926, when he returned to Wilmerding to serve as assistant director of engineering, which position he held until his recent appointment as director of research.

◆

SEVERAL changes in the Hunt-Spiller Manufacturing Corporation, South Boston, Mass., organization were made effective February 1. R. F. Harrington, metallurgist, has been promoted to chief metallurgist and will also superintend foundry operations. He was graduated from Tufts College in 1913 with the degree of bachelor of science in chemical engineering. Serving first as a chemist he has been metallurgist during the past 15 years, in which capacity he developed the metallurgical and research department. He has been succeeded as metallurgist by A. S. Wright, formerly assistant metallurgist, who has been in the service of the corporation since his graduation from Northeastern University in 1914. A. H. Lindsay,



Jordan Marsh Co.

R. F. Harrington

who has been associated with the corporation for 32 years, was appointed assistant foundry superintendent. Joseph Goostray was appointed mechanical superintendent, in charge of maintenance and operation of mechanical and electrical equipment and of all departments in which finished machined products are manufactured. A graduate of Northeastern University, he entered the service of the corporation in the pattern department. During the World War he was a chief petty officer in the United States Navy and served as chief draftsman in the Engineer and Repair Office at the U. S. Submarine Base at New London, Conn., returning to the Hunt-Spiller Corporation at the close of the war. H. E. Barber, a graduate of Lowell Institute in 1924, succeeded Mr. Goostray as mechanical engineer.

◆

V. R. WILLOUGHBY, general mechanical engineer of the American Car and Foundry Co., has been elected to the newly created office of vice-president in charge of engineering. He will continue to exercise general supervision over the engineering department, but will devote more time to design and development work, in addition to carrying on his railroad and other technical committee activities. E. D. Campbell succeeds Mr. Willoughby as general mechanical engineer, with headquarters at New York. W. F. Dietrichson becomes assistant general mechanical engineer in charge of engineering activities at the Berwick, Pa., plant. This position was formerly held by Mr. Campbell.

Mr. Willoughby received his college education at the University of Michigan, in the class of 1896, receiving a B.S. de-



V. R. Willoughby

gree in mechanical engineering. Immediately after graduating, he went to work with the Solvay Process Company. In October, 1897, he joined the Michigan Peninsular Car Company, one of the predecessors of the American Car and Foundry Company, and two years later, served at St. Louis, Mo., as assistant to the mechanical engineer. In 1901 he was transferred to the St. Charles plant of the American Car and Foundry Co., in the department of passenger car design, and in 1905, was appointed local engineer to Jeffersonville, Ind., plant of the American Car and Foundry Co. From October, 1917, Mr. Willoughby took an active part

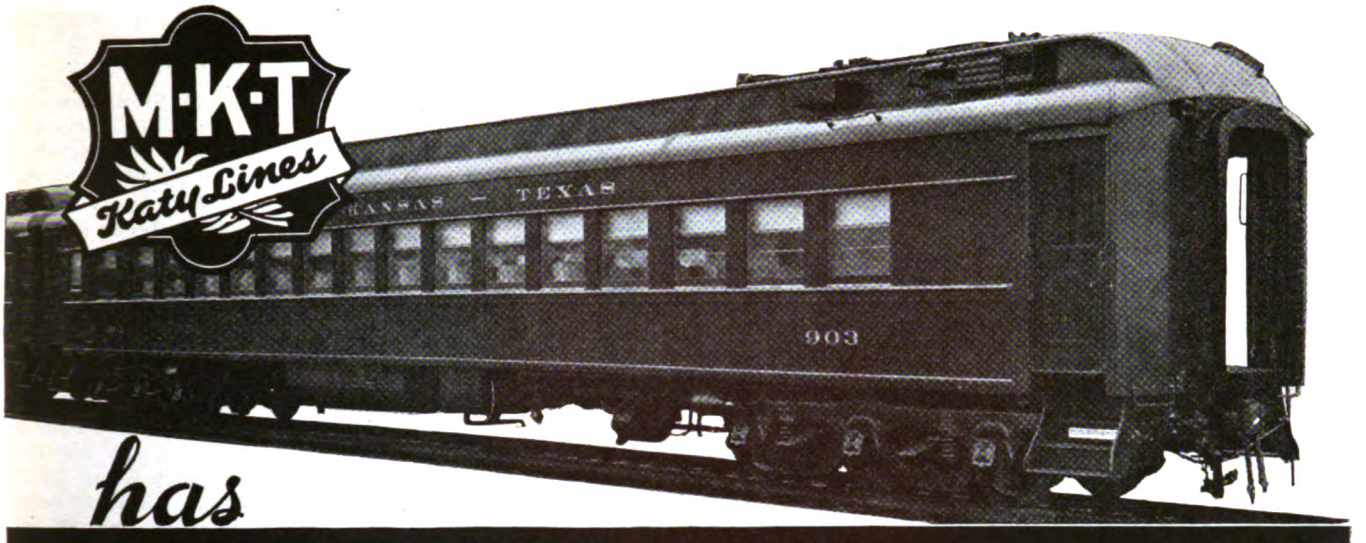


E. D. Campbell

in wartime activities of the American Car and Foundry Co., serving in the artillery and shell departments. In September, 1919, he came to the New York office in the operating department; in August, 1920, he was appointed assistant general me-

(*Continued on next left hand page*)

New Passenger Equipment



has

COMMONWEALTH TRUCKS PLATFORMS *and* END FRAMES

IMPROVEMENTS in passenger train service on the "Katy" Lines during the past several years have made a big hit with the traveling public.

Twenty-nine more units, consisting of 25 chair cars, 3 diners and 1 lounge, with features which provide the last word in comfort and convenience have just been added to their modern de-luxe equipment.

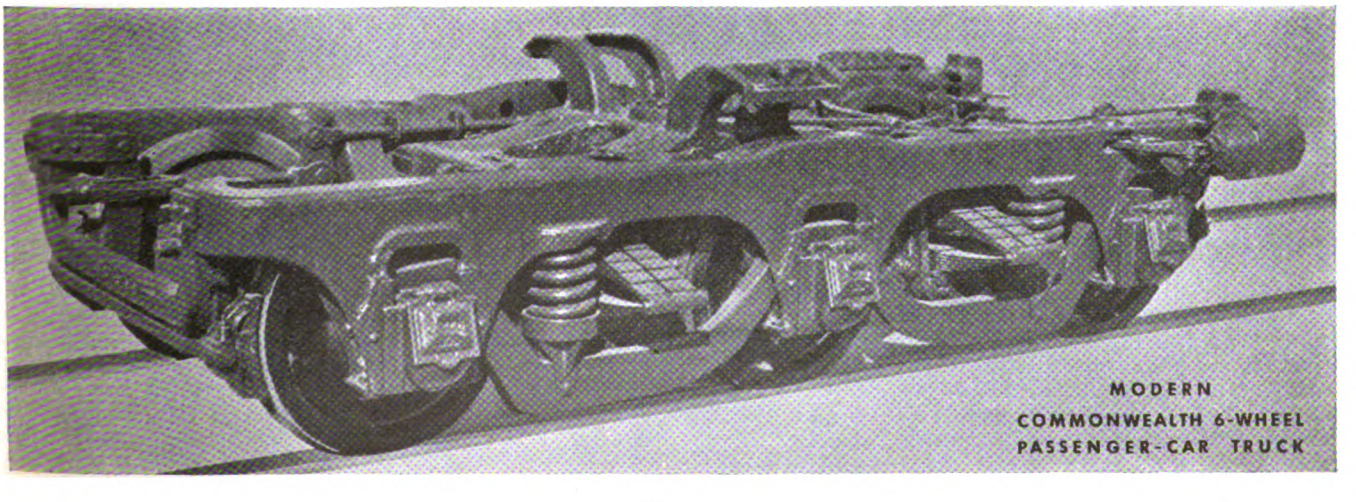
These cars, built by American Car & Foundry Co., are equipped with Commonwealth Unit Cast Steel Platforms and Double Body Bolsters, and Upright End Frame Castings, providing strongest and safest construction and insuring against telescoping of car.

Modern Commonwealth 6-Wheel Equalized Trucks, with one-piece frames and combination one-piece center and cross bolsters, provide exceptionally easy riding with lowest maintenance cost.

•

GENERAL STEEL CASTINGS

EDDYSTONE, PA. GRANITE CITY, ILL.



MODERN
COMMONWEALTH 6-WHEEL
PASSENGER-CAR TRUCK

chanical engineer and in April, 1921, acting general mechanical engineer in New York. Since January 1, 1924 he has been general mechanical engineer of the American Car and Foundry Co., now becoming vice-president in charge of engineering. Mr. Willoughby is a member of the American Society of Mechanical Engineers, and the American Society of Testing Materials. He is the inventor of many patented devices.

Mr. Campbell was educated in the Berwick, Pa., public schools and Penn State College, graduating in mechanical engineering course in the class of 1903, and in 1907, he received a master's degree of M.E. from that institution. After graduation, he served a short apprenticeship in steel car shops in the plant of the American Car and Foundry Co., at Berwick. During the years of 1905 to 1908 inclusive, he worked in the engineering department of the American Car and Foundry Co. at Berwick, and later in New York and Milton, Pa. In the fall of 1909, he went to St. Louis, Mo., to assist the chief mechanical engineer of the American Car and Foundry Co. and continued in that office until May, 1917. During the World War, he was commissioned captain in the Engineer Officers Reserve Corps and later was assigned to the Engineering Division of the Ordnance Department in Washington. In May, 1918, he was promoted to major; in 1919 he was commissioned lieutenant-colonel in the Ordnance Reserve Corps and in 1931 was advanced to colonel. After his discharge from the army in June, 1919, Mr. Campbell returned to the American Car and Foundry Co. as assistant engineer in the New York office. In 1925 when the St. Louis plant was expanding, he went to St. Louis to organize the mechanical department. In August, 1933, he was promoted to assistant general mechanical engineer at the Berwick plant, now becoming general mechanical engineer.

◆

FREDERICK T. ROBERTSON has been appointed vice-president of the Lewis Bolt



Frederick T. Robertson

& Nut Co., Minneapolis, Minn. After obtaining his engineering degree, Mr. Robertson was employed by the Canadian Pacific and the Chicago, Burlington & Quincy. Later he worked for Consoer, Older & Quinlan, consulting engineers, Chicago, and for the last six years has been in the employ of the Lewis company.

Obituary

CHARLES WATERMAN STONE, consulting engineer of the General Electric Company, died at his home in Schenectady, N. Y., on February 3, at the age of 63 years.

◆

CHARLES AUGUSTUS IVES, for many years in charge of air brake commercial and engineering activities of the General Electric Company, died on January 27, at his home in Erie, Pa. Mr. Ives was born at Racine, Wis., on August 7, 1879, and obtained his education in the public schools. He served with the Chicago, North Shore & Milwaukee, in the shops at Chicago and later was with the National Air Brake Company. In 1906 he took up his first work with the General Electric Company in the sale and servicing of air brake equipment; the following year he went to Schenectady, N. Y., for similar activity in the Railway Equipment division, transferring to the commercial department in 1908. His duties included both sales and service in connection with air brakes and air compressors. In 1914, Mr. Ives moved, with other members of the department, to the Erie works of G. E., where he was in charge of all commercial and engineering work on air brake equipment.

Personal Mention

Master Mechanics and Road Foremen

P. O. CHRISTY has been appointed master mechanic of the Illinois Central at Paducah, Ky., to succeed R. R. Royal.

A. D. HALEY has been appointed assistant master mechanic of the Illinois Central at Markham shops, Hazel Crest, Ill., succeeding P. O. Christy.

HENRY M. SHERRARD, mechanical inspector on the staff of the superintendent of motive power, Western lines of the Baltimore & Ohio, has been appointed master mechanic of the Monongah division, Eastern lines, with headquarters at Grafton, W. Va., succeeding R. H. Cline, resigned.

JOHN J. MELLEN has been appointed district master mechanic of the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Indianapolis, Ind. Mr. Mellen was born on November 19, 1890, at St. Louis, Mo. He attended the public schools at Mattoon, Ill., and on August 10, 1907, entered the employ of the C. C. C. & St. L. as machinist apprentice at Mattoon. Upon the completition of his apprenticeship in August, 1911, he served as a machinist on the Chicago & Eastern Illinois at Danville, Ill., and Villa Grove; on the Illinois Southern at East St. Louis, and on the C. C. C. & St. L. at Mattoon, until September, 1914. The following month he became enginehouse foreman at Mattoon; in March, 1917, enginehouse foreman at Mt. Carmel, Ill.; in September, 1917, enginehouse foreman at Bellefontaine, Ohio; in March, 1918, general foreman at Bellefontaine; in June, 1922, general foreman



J. J. Mellen

at Linndale, Cleveland, Ohio; in January, 1923, master mechanic of the Cincinnati Northern at Van Wert, Ohio; in March, 1930, assistant master mechanic of the C. C. C. & St. L. at Bellefontaine, and in August, 1932, general foreman at Bellefontaine. From February, 1933, until January of this year he was master mechanic of the Cincinnati Union Terminal Co. at Cincinnati, Ohio. Mr. Mellen organized the locomotive, car, stores and maintenance departments of the Cincinnati Union Terminal which was opened in March, 1933. He also organized the maintenance of equipment forces for the opening of the new Cleveland Union Terminal in 1930.

Shop and Enginehouse

E. C. RODDIE, shop superintendent of the Illinois Central at Paducah, Ky., has retired.

R. R. ROYAL has been appointed shop superintendent of the Illinois Central, with headquarters at Paducah, Ky.

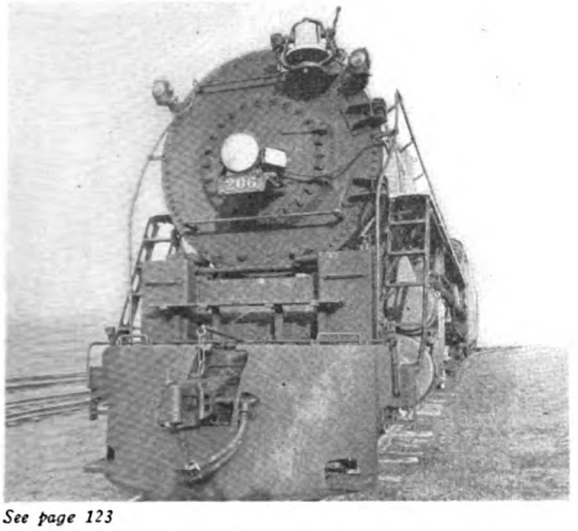
Obituary

MARK PURCELL, general air brake inspector of the Northern Pacific, with headquarters at St. Paul, Minn., died suddenly on February 8. Mr. Purcell was born on March 21, 1869. He entered the service of the Northern Pacific in 1889 in the enginehouse at East Grand Forks, Minn. After advancing successively through the positions of locomotive fireman and engineman, he became air brake instructor and then assistant general air brake inspector. He had served as general air brake inspector at St. Paul since June 1, 1911.

RAILWAY MECHANICAL ENGINEER

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.



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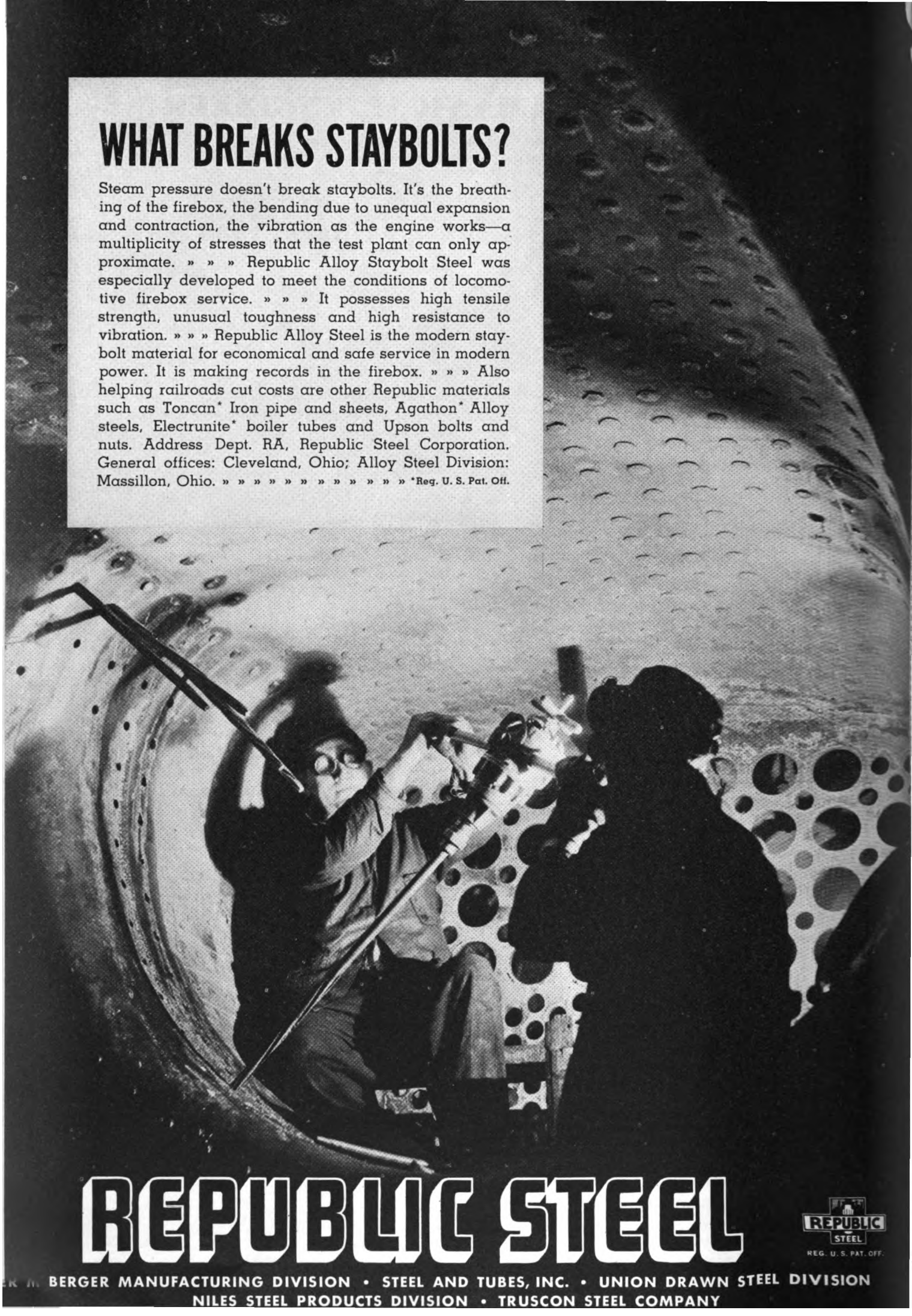
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WHAT BREAKS STAYBOLTS?

Steam pressure doesn't break staybolts. It's the breathing of the firebox, the bending due to unequal expansion and contraction, the vibration as the engine works—a multiplicity of stresses that the test plant can only approximate. » » » Republic Alloy Staybolt Steel was especially developed to meet the conditions of locomotive firebox service. » » » It possesses high tensile strength, unusual toughness and high resistance to vibration. » » » Republic Alloy Steel is the modern staybolt material for economical and safe service in modern power. It is making records in the firebox. » » » Also helping railroads cut costs are other Republic materials such as Toncan* Iron pipe and sheets, Agathon* Alloy steels, Electrunite* boiler tubes and Upson bolts and nuts. Address Dept. RA, Republic Steel Corporation. General offices: Cleveland, Ohio; Alloy Steel Division: Massillon, Ohio. » » » » » » » » » » » » *Reg. U. S. Pat. Off.

REPUBLIC STEEL

REPUBLIC STEEL
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BERGER MANUFACTURING DIVISION • STEEL AND TUBES, INC. • UNION DRAWN STEEL DIVISION
NILES STEEL PRODUCTS DIVISION • TRUSCON STEEL COMPANY

General Dimensions, Weights and Proportions of the C.M.St.P. & P. 4-8-4 Type Locomotive

Railroad	C. M. St. P. & P.
Builder	Baldwin
Type of locomotive	4-8-4
Road class	S-2
Road numbers	200-229
Date built	1938
Service	Freight
Dimensions:	
Height to top of stack, ft.-in.	16-0
Height to center of boiler, ft.-in.	10-8
Width overall, in.	130½
Cylinder centers, in.	92½
Weights in working order, lb.	
On drivers	282,320
On front truck	87,800
On trailing truck	120,330
Total engine	490,450
Tender	397,000
Wheel bases, ft.-in.:	
Driving	19- 3
Rigid	12-10
Engine, total	47- 4
Engine and tender, total	96- ¼
Wheels, diameter outside tires, in.:	
Driving	74
Front truck	36
Trailing truck, front	38
Trailing truck, back	44
Engine:	
Cylinders, number, diameter and stroke, in.	2-26x32
Valve gear, type	Walschaert
Valves, piston type, size, in.	14
Maximum travel, in.	7½
Steam lap, in.	1¼
Exhaust clearance, in.	⅛
Lead, in.	¼
Cut-off in full gear, per cent	85
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	285
Diameter, first ring, inside, in.	90 3/16
Diameter, largest, outside, in.	100
Firebox length, in.	150
Firebox width, in.	102¼
Height mud ring to crown sheet, back, in.	73⅝
Height mud ring to crown sheet, front, in.	92⅛
Combustion chamber length, in.	72
Arch tubes, number and diam., in.	2-3
Thermic syphons, number	3
Tubes, number and diam., in.	66-2¼
Flues, number and diam., in.	201-3¾
Length over tube sheets, ft.	21-0
Net gas area through tubes and flues, sq. ft.	11.32
Fuel	Soft coal
Stoker	Type B, du Pont Simplex
Grate type	Firebar
Grate area, sq. ft.	106
Heating surfaces, sq. ft.:	
Firebox	294
Comb. chamber	137
Arch tubes	18
Thermic syphons	129
Firebox, total	578
Tubes and flues	4,931
Evaporative, total	5,509
Superheat	2,336
Combined evap. and superheat	7,845
Feedwater heater, type	Wilson
Tender:	
Type	Water-bottom
Water capacity, gal.	20,000
Fuel capacity, tons	25
Trucks	Six-wheel
Journals, diam. and length, in.	7x14
Rated tractive force, engine, 85 per cent, lb.	70,800
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	57.57
Weight on drivers ÷ tractive force	3.99
Weight of engine ÷ evap. heat. surface	89.02
Weight of engine ÷ comb. heat. surface	62.51
Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	73.67
Tube-flue heat. surface, per cent comb. heat. surface	62.84
Superheat. surface, per cent comb. heat. surface	29.71
Firebox heat. surface ÷ grate area	5.45
Tube-flue heat. surface ÷ grate area	46.51
Superheat. surface ÷ grate area	21.94
Comb. heat. surface ÷ grate area	74.02
Gas area, tubes-flues ÷ grate area	0.107
Evaporat. heat. surface ÷ grate area	51.98
Tractive force ÷ grate area	667.9
Tractive force ÷ evap. heat. surface	12.84
Tractive force ÷ comb. heat. surface	9.02
Tractive force x diam. drivers ÷ comb. heat. surface	667.7

tion. Since the peaks of passenger and freight service come at different seasons, neither service interferes with the other in the assignment of the locomotives to both.

The Boiler

The boilers are of the conical-connection type. The barrel courses and welt strips, and the roof and side wrapper sheets are of silico manganese steel.

The joints between all sheets of the firebox and the 72-in. combustion chamber are butt welded. There are two Nicholson Thermic syphons in the firebox and one in the combustion chamber. The syphon flanges are butt welded in the crown. The door flanges in the back head and door sheet are lap welded. After the firebox seams have been welded on the fire side they are chipped out on the water side with a round-nose tool and are then built up on the water side.

An unusual amount of seal welding has been done on this boiler. The calking edges of the seams joining the wrapper and throat sheets to the third barrel course are welded all around. The edges of the wrapper sheets around the back head are welded after the hydraulic test and the tubes and flues are sealed in the back tube sheet by electric welding after the second fire test. The bottom edges of the firebox and wrapper sheets are welded 12 in. each way from each mud-ring corner, and the front edges of the wrapper sheet are sealed 20 in. up from the mud ring. The usual seal welding has been done at the ends of the longitudinal seams in the barrel courses.

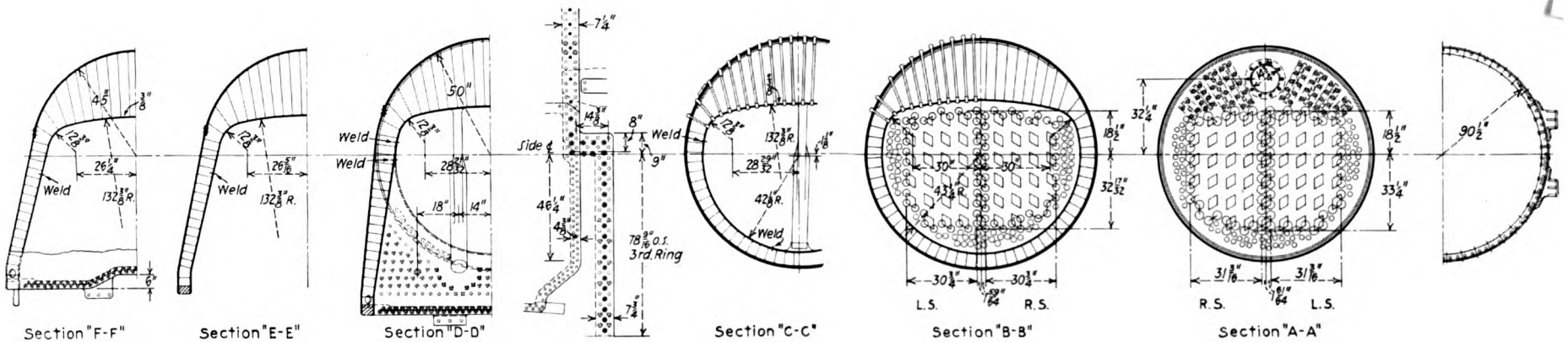
The flexible stays are the Alco type. These are applied in the four top rows below the crown stays throughout the entire length on each side of the firebox and in the two vertical rows each, immediately adjoining the back head and throat sheet. There is a complete installation of flexible stays in the combustion chamber, and the first six transverse rows of crown stays back from the tube sheet are Alco expansion stays. The remainder of the crown stays are rigid radials. There is a complete installation of flexible stays in the throat sheet, except in the top and bottom rows, and they are also applied in the two outside rows around the back head. On five of the locomotives the short rigid staybolts are made of hollow Mayari steel.

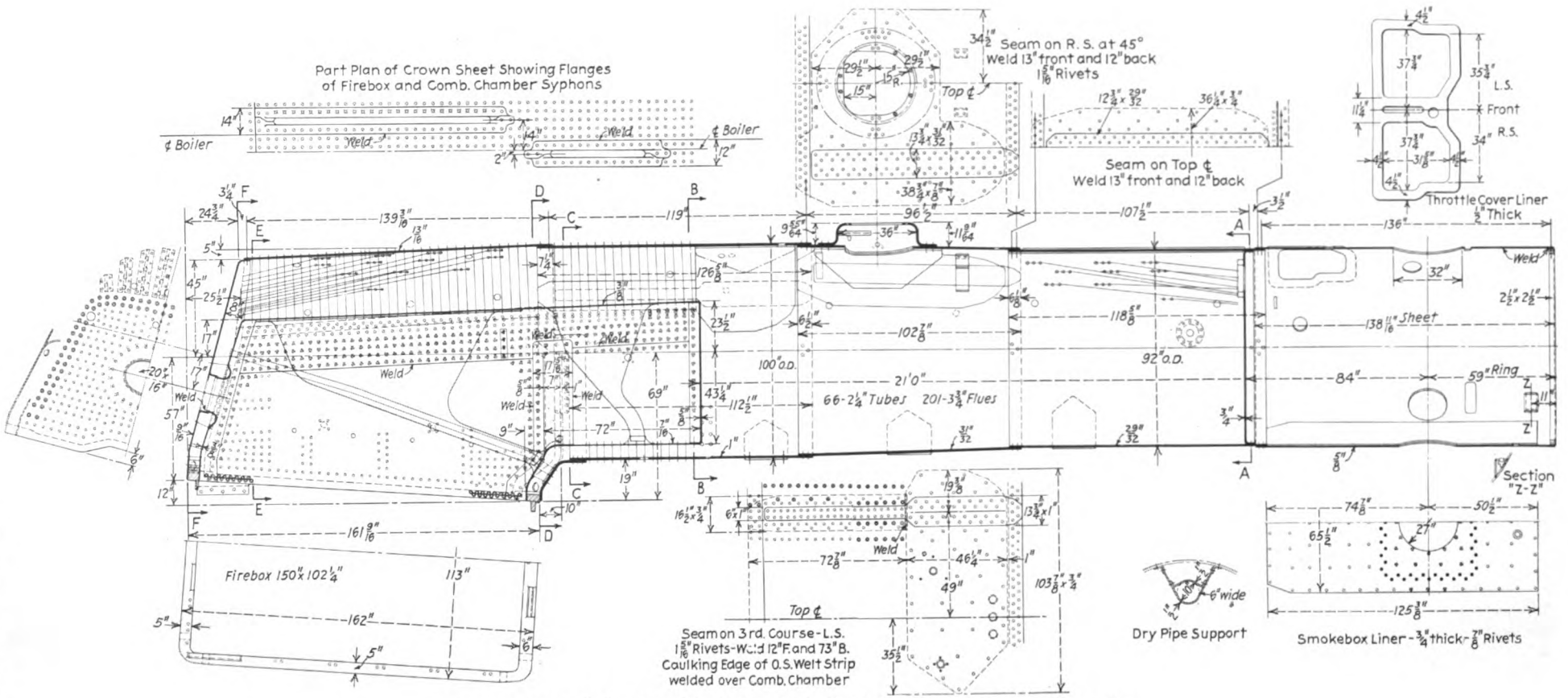
These locomotives are fitted with Firebar grates, which provide 20 per cent air openings, and are fired by a Type B du Pont Simplex stoker, the engine of which is mounted in the left front corner of the tank. The boiler equipment includes the Barco low-water alarm and the Wilson sludge remover.

The tender tank design on these locomotives required that the hot well of the Wilson feedwater heater be located about half way back in the tank instead of at the usual location in one of the front corners. The hot well in the new location on the left side of the tender holds approximately 1,000 gallons of water, from which the two-stage centrifugal pump feeds the boiler. To reach the new location the 6-in. exhaust steam return line is carried over the top of the tank. The additional length of exposed pipe, together with the fact that three sides of the hot well are exposed to the temperature of the water in the main tank and one side to the atmosphere, has effected a considerable increase in the amount of condensate returned without depleting the supply of heat below that required to bring the water to the maximum temperature allowed by the setting of the thermostatic control valve. Almost 20 per cent of the water evaporated in the boiler is now returned to the hot well.

The boilers include the Type E superheater, in the header of which is incorporated the American multiple throttle. The dry pipe is fitted with the Tangential steam drier. A departure from the customary method of securing the front end of the dry pipe in the tube sheet has been made in these locomotives. A flange on the collar at the front end of the dry pipe is welded directly to the outside of the tube sheet, thus providing a joint which is permanently steam tight.

The spark arrester is the Anderson open type in which no netting is used. It is a box installed between





Cross-sections and elevation of the boiler of the C. M. St. P. & P. 4-8-4 type locomotives

the bottom of the stack extension and the top of the exhaust nozzle, in the sides and front of which is a series of louvers placed at the proper angles to set up an effective baffling action in the path of the cinders. The smokebox is lagged and jacketed.

The Foundation, Running Gear and Driving Gear

The bed castings of these locomotives include the cylinders and integral back cylinder heads. Main reservoirs are also an integral part of the backbone of the casting and attachments are provided for the air compressors, the headlight generator, the hot-water feed pump, reverse gear, and expansion shoes at each of the four corners of the firebox. The guide-yoke crosstie, valve-motion-frame crosstie, cab-bracket supports and waist-sheet bolting lugs are also integral parts of the casting.

The pilot is of unique construction. It consists of a cast-steel frame to which steel plate is welded, secured to a vertical wall at the front of the engine bed and built so that the sloping surface extends from a point well above the deck to the bottom of the pilot. A folding type coupler is installed and, when not in use, a skirt with which it is fitted completely closes the opening in the pilot. A smooth, unbroken contour is thus provided which is said to have proved quite effective in clearing snow from the track.

The driving wheels are Boxpok cast-steel centers and the journals have Timken roller bearings in one-piece housings. An Alco lateral-motion device on the front driving wheels provides $1\frac{9}{32}$ in. lateral on each side.

The main and side rods are of low-carbon nickel steel. There is a complete installation of floating bushings on the crank pins with Hunt-Spiller fixed bushings in the rods. The front end of the main rod has $\frac{1}{16}$ in. lateral play in the crosshead. The knuckle pins are of nickel steel.

All revolving weights are counterbalanced; those in the main wheel are cross-counterbalanced. The total weight of reciprocating parts on each side is 2,287 lb., of which 39.5 per cent is balanced. This produces a calculated dynamic augment at 74 m. p. h. (diametral speed) of 11,285 lb. in each of the first and main wheels; 12,311 lb. in the third wheel, and 11,490 lb. in the fourth wheel.

The engine truck is the General Steel Castings Company four-wheel equalizer type with inside Timken roller bearings. The wheels are 36 in. in diameter and are mounted on hollow-bored axles. These trucks are fitted with the constant-resistance centering device.

The Commonwealth Delta type four-wheel trailer trucks have the American Steel Foundries roller-bearing units on both axles. The front wheels are 38 in. in diameter and the rear wheels 44 in. in diameter. The latter have cast-steel centers fitted with tires. Both axles are provided with ½-in. lateral movement. The engine-truck wheels and front trailer wheels on part of the locomotives are the Davis one-wear cast steel; on the others, Standard one-wear rolled steel.

The cylinder and valve-chamber bushings are of Hunt-Spiller gun iron. The piston heads, of rolled steel, are fitted with Hunt-Spiller gun-iron bull rings and outside packing rings, and bronze inside packing rings.

The guides and crossheads are of the multiple-bearing type. The guides are attached to the cylinder heads with the Slid-Guide expansion support.

The valves are built up of light cast-steel spiders with Hunt-Spiller lightweight bull rings and sectional packing rings on the outside, and bronze rings inside. The piston-rod and valve-stem packing is the T-Z Diamond Crescent type.

The Walschaert valve motion provides a valve travel of 7½ in. The lifting link, the reverse link, the compensating lever, the crosshead link, the eccentric rod and crank, and the motion pins are all of low-carbon nickel steel. The pins are casehardened. The reverse gears on half of the locomotives are Baldwin and on the other half Alco.

Lubrication

Each locomotive has two force-feed lubricators. On the right side is a Nathan Type DV5, 26-pint lubricator which is lagged. There are five feeds, two of which lead to the cylinders, two to the valves and one to the stoker engine. On the left side of each locomotive is an unlagged 24-pint, five-feed lubricator with four-way dividers from each feed. Four of the lines lead to guide terminal checks; the remainder, to driving-box terminal checks for the lubrication of the driving-box shoes. These lubricators are Detroit's on half of the locomotives and Chicago's on the remainder. Air-compressor lubrication is furnished by a Westinghouse force-feed pump lubricator. This lubricator also takes care of the turbo generator.

These locomotives have an extensive installation of Alemite fittings. In addition to the rods and valve motion, these fittings are applied on the brake rigging, spring rigging, truck pedestals and center plates, and to the furnace bearers as well as to numerous other bearing or wearing surfaces on the locomotive and tender.

Cabs and Auxiliary Equipment

The brakes are No. 8ET Westinghouse with two 8½-in. cross-compound compressors. The driving wheels are fitted with long brake shoes. Both the engine truck and the trailer wheels have clasp brakes. The braking ratio on the drivers is 60 per cent; on the engine truck, 45 per cent, and on the trailer, 50 per cent. The locomotives have Union Switch & Signal Company three-indication cab signals.

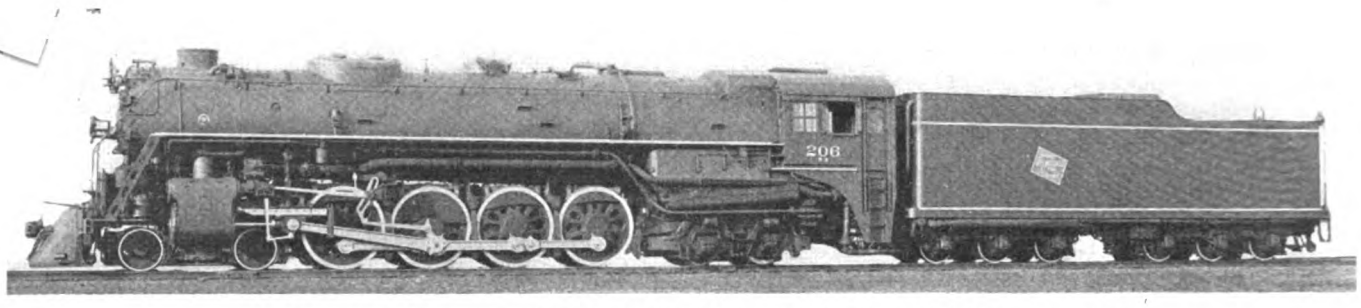
The saturated-steam turret is located under a housing above the roof sheet in front of the cab and is supplied by two dry pipes opening in the dome. Steam from the turret is delivered to all auxiliaries except the whistle, the turbo generator and the air compressors. Superheated steam is supplied to the whistle, air pumps and turbo generator from a turret on the left side of the smokebox.

Both the air compressors and the generator are installed on the bed casting under the smokebox. The latter is protected by a casing. To avoid outside piping the exhaust from these three auxiliary units is brought together in a header outside the smokebox which is connected to a tunnel that follows the inside contour of the smokebox and discharges into a compartment in the forward section of the smoke stack. This tunnel is welded to the smokebox and spark shields protect it against abrasion. The cavity in front of the stack, with which it is cast integral, contains a deflector so arranged as to serve as a muffler, thus almost entirely damping out the sound of the air-pump exhaust.

As far as possible the piping above the running board has been placed under the jacket and, although not streamline, the locomotive presents a generally neat appearance.

The equipment of these locomotives includes the Ashcroft back-pressure gage and the Chicago Pneumatic Tool Model CT speed recorder.

The cabs are of the vestibule type. A recess in the exterior of the side of the cab at floor height provides a toe hold for passing from the cab to the running board. A suitable handhold is located at the top of the



A 4-8-4 type freight locomotive built for the C. M. St. P. & P. by the Baldwin Locomotive Works

windows. The cabs are wood lined and the sides, roofs and floors insulated. They are fitted with Prime Clear Vision windows of shatterproof glass.

In addition to the seats for the engineman and fireman, drop seats are provided against the rear wall of the cab for the use of the brakeman. When set up, these seats are opposite windows with arm rests in the cab-vestibule doors. All cab seats have Spongex cushions. There are wind shields in front of the vestibule-door windows as well as in front of the engineman's and fireman's positions. The cab ventilator is operated by a gear and rack device in which provision is made for locking so that the ventilator will not creep.

The engine and tender are coupled by a Unit Safety drawbar and a Type E-2 radial buffer. The pipe connections are Barco flexible metallic conduit.

Tender

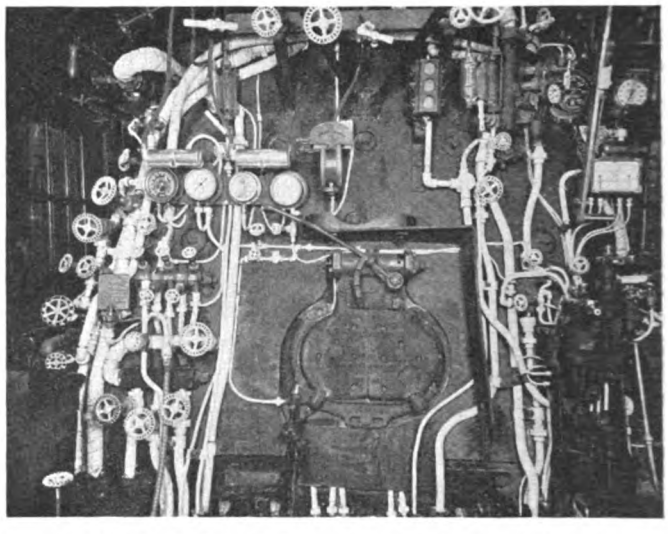
The tender underframe is a General Steel Castings water-bottom type in which the sump for the Wilson feedwater heater is cast integral. The tank is of welded construction throughout.

There are two General Steel Castings six-wheel trucks with an 11-ft. wheel base. These trucks have 38-in. wheels and are mounted on axles with 7-in. by 14-in. journals which are fitted with the American Steel Foundries roller-bearing units with SKF bearings. The wheels on part of the locomotives are Davis one-wear cast steel, and on the remainder Standard one-wear rolled steel. The brakes are the Simplex unit-cylinder clasp type with one brake cylinder per truck and have a braking ratio of 80 per cent of the tender light weight. Miner A-78-XB draft gear is applied at the rear end of the tender.

The principal dimensions, weights and proportions of the locomotives are shown in one of the tables.

Partial List of Materials and Equipment on the C. M. St. P. & P. 4-8-4 Type Locomotives

Firebox steel	Lukens Steel Co., Coatesville, Pa.
Staybolt steel, Mayari (short rigid bolts)	(5) Bethlehem Steel Co., Bethlehem, Pa.
Staybolt iron (other staybolts)	(5) Ewald Iron Co., Louisville, Ky.
Staybolt iron	(25) Joseph T. Ryerson & Son, Inc., Chicago; Blatchford Corp., Chicago
Flexible staybolts and expansion stays	(30) American Locomotive Co., New York
Tubes and flues	Globe Steel Tubes Co., Milwaukee, Wis. National Tube Co., Pittsburgh, Pa.
Arch tubes	Globe Steel Tubes Co., Milwaukee, Wis. National Tube Co., Pittsburgh, Pa.
Nicholson Thermic syphons	Locomotive Fire Box Co., Chicago
Firebrick arch	Universal Locomotive Arch Co., Chicago
Superheater, Modified Type E, and Elesco Tangential steam drier	The Superheater Company, New York
Front-end throttle	American Throttle Co., New York
Smokebox hinges	The Okadee Company, Chicago
Smokebox door gaskets	The Garlock Packing Company, Palmyra, N. Y.
Smoke prevention nozzles and smokebox drain plugs	T-Z Railway Equipment Co., Chicago
Pipe	Reading Iron Company, Philadelphia, Pa. Standard Sanitary Mfg. Co., Pittsburgh, Pa.
Pipe fittings	Crane Co., Chicago Walworth Company, New York
Boiler jacket	Bethlehem Steel Co., Bethlehem, Pa.
Lagging	(24) Johns-Manville Sales Corp., New York; (3) United States Gypsum Co., Chicago; (3) Philip Carey Mfg. Co., Lockland, Ohio
Pipe covering	Union Asbestos & Rubber Co., Chicago
Steampipe casing, Flextite	American Locomotive Co., New York
Feedwater heater	Wilson Engineering Corp., Chicago
Injectors and feedwater heater and injector checks	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Flue blower	Superior Railway Products Corp., Pittsburgh, Pa.
Blower fittings	Barco Manufacturing Co., Chicago
Blower nozzle	T-Z Railway Equipment Co., Chicago
Sludge remover and exhaust separators; power operated blow-off equipment	Wilson Engineering Corp., Chicago
No-Ox-Id (tank interior and inside cab sheets)	Dearborn Chemical Company, Chicago



The back head of the C. M. St. P. & P. 4-8-4 type locomotive

Washout plugs	(25) T-Z Railway Equipment Co., Chicago; (5) Huron Mfg. Co., Detroit, Mich.
Strainer	T-Z Railway Equipment Co., Chicago
Stoker, Modified type B du Pont Simplex	Standard Stoker Co., Inc., New York
Stoker gage	Ashton Valve Co., Boston, Mass.
Firedoor, Butterfly	Franklin Railway Supply Co., Inc., New York
Firebar grates	Waugh Equipment Co., New York
Cab insulation, Hairinsul	American Hair & Felt Co., Chicago
Cab apron and deck plate, Firmotread	Joseph T. Ryerson & Son, Inc., Chicago
Running boards, Saf-Car	Irving Iron Works Co., Long Island City, N. Y.
Clear vision windows; windshields	The Prime Manufacturing Co., Milwaukee, Wis.
Cab seat cushions	Sponge Rubber Products Co., Derby, Conn.
Steam valves	(15) Crane Co., Chicago; (15) Ohio Injector Co., Wadsworth, Ohio
Back pressure gage	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Water columns and gage cocks	The Prime Manufacturing Co., Milwaukee, Wis.
Steam gages and safety valves; back-pressure gage	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Speed recorder	Chicago Pneumatic Tool Co., New York

(*Continued on page 140*)

Simplified Formulas for Calculating the

Air Resistance of Trains*

By A. I. Lipetz †

Complex air-resistance formulas are used to develop the simple formulas given in this article—A comparison of the air resistances of streamlined and standard railroad equipment as computed by both types of formulas is made to prove the validity of the simple formulas

HEREIN are presented simplified formulas for evaluating the resistance of air to the motion of railroad motive power and equipment. These formulas are based on data and formulas presented by Professor A. Klemin in a report[1] to the American Locomotive Company, the American Car & Foundry Company and the J. G. Brill Company, which companies sponsored an extensive program of wind-tunnel tests on models of railroad trains in the wind tunnel at New York University during the summer of 1934. In previous articles in the *Railway Mechanical Engineer*, Professor Klemin[2] discussed the procedure for making wind-tunnel tests; G. W. DeBell and A. I. Lipetz[3] discussed the previously mentioned test program, described the types of equipment tested, and gave formulas for evaluating air resistance which are more complicated than those presented in this present article; and G. W. DeBell[4] reviewed that portion of the report[1] which pertains to ground winds.

In the previously mentioned test program, the following types of equipment were studied:

1—Streamlined power car with two types of streamlined nose, and standard and faired trucks.

2—A tail car with two types of tail, and standard and faired trucks.

3—Intermediate streamlined cars with standard and faired trucks, and also open and closed skirts.

4—A streamlined 4-6-4 Hudson-type locomotive with three types of nose, i. e., helmet, round and straight; two types of boilers, i. e., round top and cowled top; and three types of shroud, i. e., long, short and open.

5—A standard 4-6-4 Hudson-type steam locomotive.

6—Standard cars which were tested with the standard locomotive.

7—Streamlined 4-4-4 locomotives with round-top and cowled-top boilers.

8—A standard 4-6-4 steam locomotive.

Equipment mentioned in paragraphs 1, 2, 3, 4, 5 and 6 were made to 1/16 scale while the locomotives mentioned in paragraphs 7 and 8 were made to 1/32 scale. Much of this equipment was illustrated and described by DeBell and Lipetz in a previous article,[3] who also discussed the tests conducted with it.

Full-Scale Formulas and Their Simplification

Klemin has reported that full-scale air resistance can be established as

$$R_a = R_p + R_f \quad \ldots\ldots [1]$$

$$R_a = K_p V^2 + K_f V^{1.85} \quad \ldots\ldots [2]$$

were R_a is the total air resistance, R_p is the head-end pressure resistance, R_f is the resistance due to skin-friction drag, K_p is the coefficient for head-end pressure resistance, K_f is the coefficient for resistance due to skin-friction drag, and V is velocity in m. p. h. Values of K_p and K_f for all the tests[1] are given in Table I. For example, the air resistance for a streamlined steam locomotive with tender and tail car and corresponding nose, boiler and shroud can be expressed as

$$R_a = 0.1126V^2 + 0.0535V^{1.85}$$

where $K_p = 0.1126$ and $K_f = 0.0535$ were taken from test No. 21 in Table I.

The method of expanding the coefficients from model tests to full-scale equipment, proposed by Klemin,[1] is based on scientific grounds and has the advantage that the coefficients K_p and K_f are constant, that is, they are the same for models and full-scale equipment. In the report made by Klemin,[1] a formula of the two-member type, such a formula [2], is given for each type of equipment tested.

After the report[1] was made, the author of this article wished to find out what is to be gained by using the two-member formula, in which one of the terms has the unusual exponent of 1.85, and whether the one-member formula of the V^2 type, such as equation [7], would not do; in case it should, the author wanted to know what error this simplification would involve.

Therefore, the author developed a one-member formula for determining the air resistance of all the types of equipment enumerated in Table I. He then computed the air resistance of each type, using both Klemin's two-member formulas and his own one-member formulas, and found that the results obtained with both formulas were practically identical, thus justifying the use of the one-member formulas. To illustrate this fact, the author will show how the one-member formulas were developed for (1) the streamlined power car with a tail car and two streamlined coaches used in Test No. 18, and (2) the standard locomotive and tender used in Test No. 28. He will then compare the results obtained with one-member and two-member formulas for these two types of equipment.

The formula recommended by Klemin[1] on the bases of Test No. 18, results of which are given in Table I, is

$$R_a = 0.1116V^2 + 0.0774V^{1.85} \quad \ldots\ldots [3]$$

The author calculated the air resistance of the equipment used in Test No. 18 for speeds at intervals of m.p.h. from 10 to 120 m.p.h. and plotted the results as

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* Abridged from the paper "Air Resistance of Railroad Equipment," by A. I. Lipetz, which was published in the Transaction of the American Society of Mechanical Engineers, vol. 59, No. 7, October, 1937, pp. 617-640.

† Chief Consulting Engineer, in charge of research, American Locomotive Company, Schenectady, N. Y.

[1] "Wind Tunnel Test Report No. 717," "Daniel Guggenheim School of Aeronautics, New York University, New York, N. Y., July, 1934.

[2] "Aerodynamics of the Railway Train," by A. Klemin, *Railway Mechanical Engineer*, vol. 108, August, September and October, 1934, pp. 282, 312 and 357, respectively.

[3] "Air Resistance of Passenger Trains," by G. W. DeBell and A. I. Lipetz, *Railway Mechanical Engineer*, vol. 109, December, 1935, p. 496.

[4] "Effect of Natural Winds on Air Drag," by G. W. DeBell, *Railway Mechanical Engineer*, vol. 110, April, 1936, p. 145.

Table I—Results of Drag Tests Made With Models at New York University

Test No.	Equipment	Skirt	Power truck	Trailing truck	Diaphragm	Tail fairing*	Type of nose†	Type of boiler	Type of Shroud	Scale of model	K_p	Kf	K	a	A, sq. ft.	Per cent of KV^2 — 30 m.p.h.	120 m.p.h.
18	P+T+2SC	Open	Faired	Standard	Smooth	No. 2	No. 2	..	.....	1/16	0.1116	0.0774	0.1503	0.001691	88.89	−4.9	+0.63
18A	P+T+2SC	Open	Faired	Standard	Cowled	No. 2	No. 2	..	.....	1/16	0.1149	0.0774	0.1536	0.001728	88.89	−4.8	+0.62
19	P+T+1SC	Open	Faired	Standard	Smooth	No. 2	No. 2	..	.....	1/16	0.0882	0.0614	0.1189	0.001337	88.89	−4.9	+0.64
20	P+T	Open	Faired	Standard	Smooth	No. 2	No. 2	..	.....	1/16	0.0744	0.0437	0.0962	0.001082	88.89	−4.4	+0.51
21	SL+T	Open	....	Standard	Smooth	No. 2	H	RT	Closed	1/16	0.1126	0.0535	0.1393	0.001010	137.98	−3.6	+0.58
22	SL+T	Open	....	Standard	Smooth	No. 2	R	RT	Closed	1/16	0.1152	0.0535	0.1419	0.001029	137.98	−3.6	+0.50
23	SL+T	Open	....	Standard	Smooth	No. 2	S	RT	Closed	1/16	0.1147	0.0535	0.1414	0.001025	137.98	−3.6	+0.50
24	SL+T	Open	....	Standard	Smooth	No. 2	H	CT	Closed	1/16	0.1161	0.0535	0.1428	0.001035	137.98	−3.5	+0.57
25	SL+T	Open	....	Standard	Smooth	No. 2	H	RT	Open	1/16	0.1156	0.0535	0.1423	0.001032	137.98	−3.5	+0.57
26	SL+T	Open	....	Standard	Smooth	No. 2	H	RT	Short	1/16	0.1308	0.0535	0.1575	0.001142	137.98	−3.3	+0.39
27	SL	....	....	.....	.....	....	H	RT	Closed	1/16	0.1094	0.0363	0.1275	0.000924	137.98	−2.8	+0.31
28	NL	....	....	.....	.....	....	....	..	.....	1/16	0.2400	0.0421	0.2611	0.001906	136.96	−1.7	+0.21
29	NL+1NC	....	....	.....	.....	....	....	..	.....	1/16	0.3103	0.0636	0.3420	0.002498	136.96	−1.8	+0.20
30	NL+2NC	....	....	.....	.....	....	....	..	.....	1/16	0.3709	0.0830	0.4124	0.003011	136.96	−1.9	+0.27
31	NL+3NC	....	....	.....	.....	....	....	..	.....	1/16	0.3975	0.1023	0.4486	0.003276	136.96	−2.2	+0.16
32	NL	....	....	.....	.....	....	....	..	.....	1/32	0.2337	0.0421	0.2547	0.001859	136.96	−1.7	+0.19
33	NL+1NC	....	....	.....	.....	....	....	..	.....	1/32	0.3025	0.0636	0.3343	0.002441	136.96	−1.8	+0.23
34	NL+2NC	....	....	.....	.....	....	....	..	.....	1/32	0.3518	0.0830	0.3933	0.003871	136.96	−2.1	+0.26
35	NL+3NC	....	....	.....	.....	....	....	..	.....	1/32	0.4082	0.1023	0.4593	0.003353	136.96	−2.2	+0.27

Notations: P = power car; T = tail car; SC = streamlined car; SL = streamlined locomotive; NL = nonstreamlined (standard) locomotive; NC = nonstreamlined (standard) car; H = helmet-type nose; R = round nose; S = straight nose; RT = round top; CT = cowled top.

* The No. 2 streamlined tail fairing mentioned in this column is illustrated in Fig. 5 of the article "Air Resistance of Passenger Trains," by G. W. DeBell and A. I. Lipetz, *Railway Mechanical Engineer*, vol. 109, December, 1935, p. 497.

† The No. 2 nose mentioned in this column is illustrated in Fig. 4 of the article referred to in the preceding footnote. The helmet, round and straight noses are illustrated in Fig. 11 of the same article.

‡ Errors are in relation to $(Kp^{1.85} + Kf^{1.85})$.

crosses in Fig. 1. He then found that the resistances so plotted can be represented very well by the parabolic one-member formula

$$R_a = KV^2 = 0.1503V^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

The parabolic curve was found by the method of least squares. The differences in resistances obtained by formulas [3] and [4] are given in Table II. This justifies the use of the one-member formula, because the difference is negligible; at low speeds the percentage difference may seem large, but actually it amounts to a few pounds. At high speeds (about 100 m.p.h.) it is less than a small fraction of one per cent. Besides, small speeds, below 50 m.p.h., are now of little practical interest.

Fig. 1—Comparison of resistance curves from Test No. 18

All two-member formulas derived from the tests were similarly analyzed and the results were the same. It was found that every two-member formula, of the type such as formula [1], can be replaced by a one-member formula of the type such as formula [4]. This is true not only for streamlined equipment, but for nonstreamlined

Table II—Comparison of Air Resistances Obtained by Using Formulas [3] and [4]

Speed, m.p.h.	R_a from formula [3], lb.	R_a from formula [4], lb.	Difference, per cent
10	16.6	15.0	−9.67
20	64.4	60.1	−6.63
30	142.3	135.3	−4.92
40	249.8	240.5	−3.72
50	386.6	375.8	−2.81
60	552.5	541.1	−2.07
70	747.4	736.5	−1.46
80	971.0	961.9	−0.93
90	1,223.2	1,217.4	−0.47
100	1,503.9	1,503.0	−0.06
110	1,813.1	1,818.6	+0.31
120	2,150.6	2,164.3	+0.64

equipment as well. In Fig. 2 a comparison of curves for a standard locomotive and tender (test No. 28) is made. The formula resulting from the test and recommended by Klemin[1] is

$$R_a = 0.2400V^2 + 0.0421V^{1.85} \quad \ldots\ldots [5]$$

and is represented by the crosses for speeds between 10 and 120 m.p.m. The curve shown in Fig. 2 is a one-member parabola

$$R_a = 0.2611V^2 \quad \ldots\ldots [6]$$

The comparison of air resistances obtained by formulas [5] and [6], is given in Table III.

It seems that the air resistance of a nonstreamlined locomotive can be represented by a V^2 formula better than a streamlined locomotive. This can be explained by the fact that the nonstreamlined locomotive causes more turbulence, which follows the V^2 law, while the streamlined locomotive has more skin friction, which follows the law with an exponent of 1.85. In either case the V^2 formula can be used for all practical purposes.

One remark would not be amiss here in this connection. It should not be thought that, because of the admissibility of the V^2 law, we could, for establishing the full-scale formulas, expand the coefficient from the model tests simply by increasing their values in the inverse ratio of the square of the scale, as being done by some experimenters.

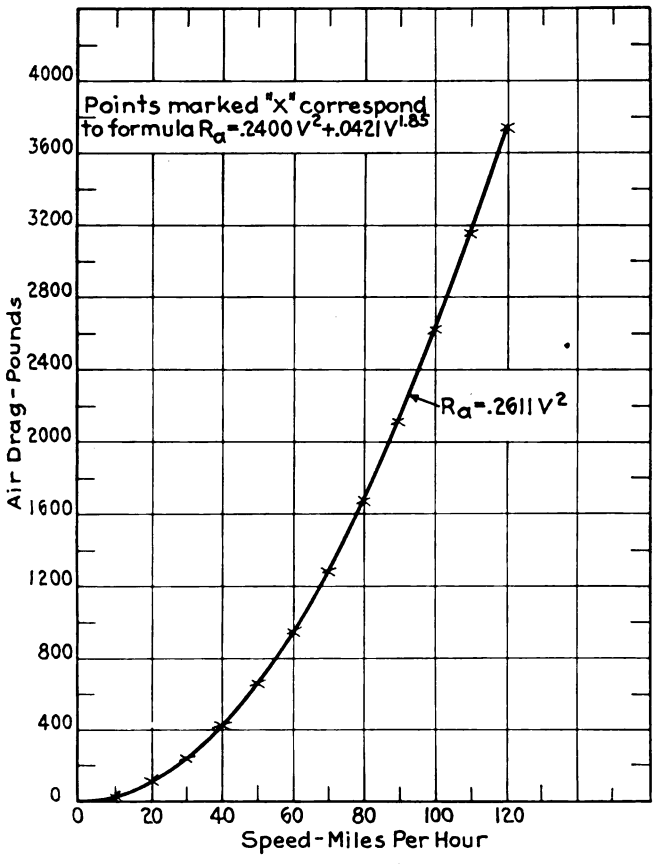


Fig. 2—Comparison of resistance curves from Test No. 28

For example, let us take the net values of air resistances from the model equipment used in Test No. 18, multiply these values by the square of the inverse ratio of the scale, and compare them with the resistances for full-scale equipment given in Table II. This has been done in Table IV, from which it will be observed that the values obtained by multiplying the drag values by the square of the inverse ratio of the scale are greater than the values of R_a obtained by formulas [3] and [4] for corresponding speeds. This is because that portion of the air resistance which is due to skin friction is then multiplied by $16^2 = 256$, while it should be multiplied only by $16^{1.85} = 169$. By using the two-member formula with two different exponents (2 and 1.85) the scale effect was properly corrected, after which the simplification through the one-member formulas was entirely permissible, as this gave practically identical numerical values.

Thus, all two-member formulas of the type

$$R_a = K_pV^2 + K_fV^{1.85} \quad \ldots\ldots [2]$$

derived from the New York University tests[1] have been converted into one-member V^2 formulas of the form

$$R_a = KV^2 = aAV^2 \quad \ldots\ldots [7]$$

Coefficients K_p, K_f, K, a, and A for each formula are given in Table I. The maximum errors of this conversion at 30 and 120 m.p.h. are also shown in Table I for each test.

Further Simplifications

After the admissibility of the one-member V^2 formulas had been established for all practical purposes, a further simplification was found to be possible in evaluating the influence of the length of the train. DeBell and Lipetz in a previous article[3] recommended formulas in which the length of the train was expressed as an exponential term.

Table III—Comparison of Air Resistances Obtained by Using Formulas [5] and [6]

Speed, m.p.h.	R_a from formula [5], lb.	R_a from formula [6], lb.	Difference, per cent
10	27	26.1	-3.33
20	107	104.4	-2.39
30	239	234.9	-1.72
40	423	417.8	-1.23
50	659	652.7	-0.96
60	946	940.0	-0.63
70	1,285	1,274.4	-0.83
80	1,676	1,671.0	-0.30
90	2,118	2,114.9	-0.15
100	2,611	2,611.0	0.00
110	3,156	3,159.3	+0.10
120	3,752	3,759.8	+0.21

For example, the following formulas were established for power-car trains in still air:

For cars with open skirts (18 in. from skirt to top of rail)

$$R_a = 0.00224P_c\,(L/100)^{0.5}\,V^2 + \Sigma KV^2 \quad \ldots\ldots [8]$$

while for cars with closed skirts (completely under the car), a similar formula was recommended

$$R_a = 0.0020P_c\,(L/100)^{0.5}\,V^2 + \Sigma KV^2 \quad \ldots\ldots [9]$$

In these formulas P_c = perimeter of car from plane of top of rails over car to plane of top of rails, ft.; L = overall length of train, ft.; V = speed of train, m.p.h. and ΣK = summation of factors ($K_1 + K_2$, etc.) of the various items whose drag depends on dimensions other than perimeter and length. The factors K were given in DeBell and Lipetz's article.[3]

Similar formulas were given in the article[3] for streamlined trains pulled by separate locomotives and nonstreamlined (standard) trains.

The air-resistance coefficients for streamlined trains, using these formulas, are shown in Fig. 3 by dashed lines. It can be easily seen that by replacing the curved portions of the dashed curves by straight lines (the solid curves), the error is very small. Therefore, the author of this article suggested that instead of formula

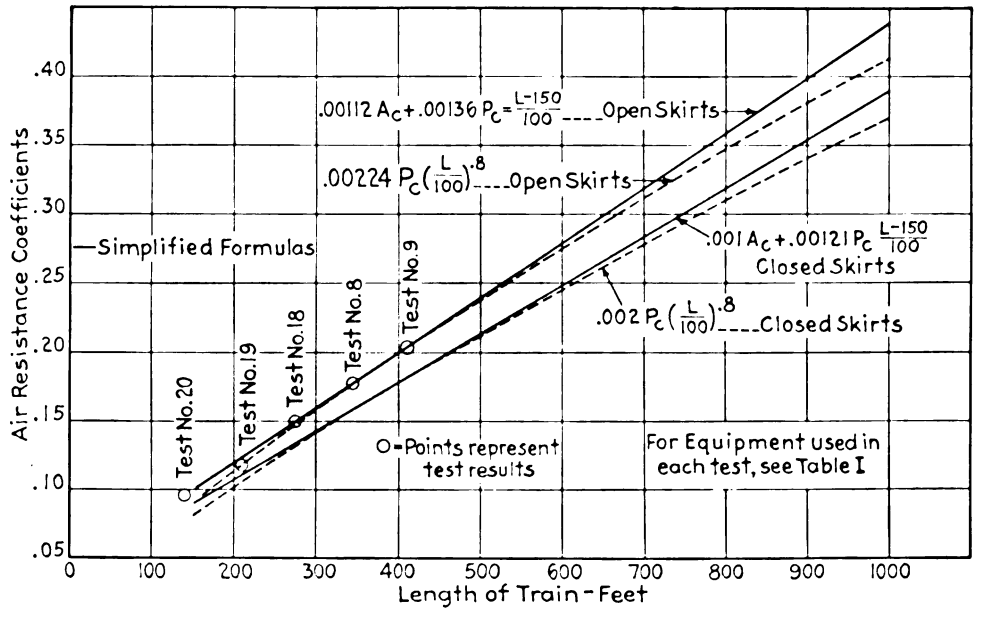


Fig. 3—Air-resistance coefficients of streamline trains

[8] for open skirts, the following formula for fully streamlined power cars with open skirts be used:

$$R_a = (0.00112A_c + 0.00136P_c \frac{L-150}{100} + \Sigma K)\, V^2 \quad \ldots [10]$$

where A_c = frontal (cross-section) area of the train, sq. ft.; P_c = perimeter of cars from plane of top of rails over car to plane of top of rails on the other side; ft.; L = overall length of train, including the front (power) car, ft.; and V = speed of train, m.p.h. The values of ΣK (K_1, K_2, K_3, etc.) given in DeBell and Lipetz's article[3] remain unchanged.

No drag-test values for trains longer than 410 ft. were observed, and the branch of the exponential curve beyond this length, up to 1,000 ft., was previously obtained by extrapolation. In other words, there is no good reason why the straight-line formula [10] should not be taken as justified by test. Furthermore, the difference between these and the exponential formulas for a train length of 1,000 ft. does not exceed 6 per cent; i.e., the questionable portions of the curves are not worth considering.

Likewise, for closed skirts the coefficients of the formula should be reduced, and the formula will thus be

$$R_a = (0.001A_c + 0.00121P_c \frac{L-150}{100} + \Sigma K)\, V^2 \quad \ldots [11]$$

The first members of formulas [10] and [11], depending upon A_c, represent the head resistance, while the second members, with P_c, are mainly skin-friction resistances.

As the power car with tail car cannot be much shorter than 150 ft., the formulas can be applied to any power car, rail car, or train. If they are shorter, the numerators in formulas [10] and [11] become negative. This is correct, because the skin friction of the car is less. However, the formulas should not be applied to cars shorter than 100 ft. For such, only the first member, with A_c, should be used.

The streamlined-train tests were made with a power car, tail car and a number of streamlined coaches. For locomotive trains, tests were made with the locomotive and tender alone, without a tail car, and the locomotive with a tail car, but always without coaches, since streamlined-train data can be used with the resistance of cars in a locomotive train as established by the foregoing formulas.

Regarding streamlined steam locomotives, values of locomotive resistance with different noses, boilers, and shrouds are given in Table I. For practical purposes it is advisable to consider the resistance of the best streamlined locomotive as a basis and correct this figure, as it was done with the cars of the streamlined train, by adding the differences K due to the omission of one or another feature of good streamlining. The lowest resistance was found for the streamlined locomotive with helmet nose, round-top boiler, and long (closed) shroud (test No. 27), namely

$$R_{al} = 0.1275 = 0.000924A_L \quad \ldots [12]$$

where A_L is the frontal area of the streamlined locomotive, which is 137.98 = 138 sq. ft.

Regarding the different corrections K, ΣK is the summations of factors ($K_1 + K_2 +$, etc.) of the various items of which the drag depends on other dimensions than perimeter and lengths. The values of K were given in a previous article.[3]

On the basis of the foregoing, the formula for a streamlined train consisting of cars with open skirts and hauled by a streamlined locomotive is

$$R_a = (0.000924A_L + 0.00136\, P_c \frac{L-100}{100} + \Sigma K)\, V^2 \quad \ldots [13]$$

If the streamlined cars of the train have closed skirts, the formula should be

$$R_a = (0.000924A_L + 0.00121\, P_c \frac{L-100}{100} + \Sigma K)\, V^2 \quad \ldots [14]$$

In formulas [13] and [14], A_L is the frontal area of the locomotive. Other notations are the same as before. For coefficient 0.000924 see Table I, Test No. 27.

Similar to what was said regarding formulas [10] and [11], the second members in brackets of formulas [13] and [14] have the subtrahends in the numerators equal to 100, as a round figure, because the length of the tested locomotive and tender was 96 ft., and the error is slight, as compared with what we would have had if the subtrahends were taken equal to 96. If the locomotive is longer, or shorter, the adjustment will be made automatically when the correct length of the locomotive will be included in the total length L of the train.

Irrespective of the subtrahends of the members in the brackets, 100 or 150, the increase of the air-resistance coefficient per 100 ft. of train length is always the same.

For streamlined cars with open skirts the increase is, according to formula [13]

$$0.00136P_c \quad \ldots\ldots\ldots\ldots\ldots\ldots [15]$$

and for streamlined cars with closed skirts, it is

$$0.00121P_c \quad \ldots\ldots\ldots\ldots\ldots\ldots [16]$$

The perimeter of streamlined cars P_c usually varies between 28 ft. 6 in. and 31 ft. 6 in., the average being 30 ft. For our test cars, P_c was 29.33 ft. For open skirts, formula [15] will give at $P_c = 30$, or $0.00136 \times 30 = 0.0408$, and formula [16] will give, for closed skirts, $0.00121 \times 30 = 0.0363$. Thus, a very simple approximate rule can be established for air resistance R_a of streamlined trains. The rule is

$$R_a = KV^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots [17]$$

where K is the general locomotive and train air-resistance coefficient, equal to the sum of K's for locomotive and cars, and V is the speed, m. p. h. For the locomotive, K should be taken from Table I (tests Nos. 21-27), depending upon the nature of streamlining. For every 100 ft. of the length of cars, 0.0408 should be added for open skirts, while 0.0363 should be added for closed skirts.

Table IV—Comparison of Air Resistances Obtained from Formulas [3] and [4] with Those Obtained by Increasing the Resistances of the Model in the Inverse Ratio of the Square of the Model Scale*

1	2	3	4	5	6
Speed m.p.h.	Air resistance of model used in test No. 18, lb.	Inverse of model scale squared	Product of col. 2 and col. 3, lb.	R_a from formula [3], lb.	R_a from formula [4], lb.
30	0.600	256	153.6	142.3	135.3
40	1.122	256	287.2	249.8	240.5
50	1.784	256	456.7	386.6	375.8
60	2.510	256	642.5	552.5	541.1
70	3.502	256	896.5	747.4	736.5

* The equipment for which these values are applicable are given in Table I under test No. 18.

For instance, if we have a train consisting of a locomotive 100 ft. long, with helmet nose, round-top boiler, and short shroud uncovering the drivers, and of four streamlined 70-ft. cars with open side-sill skirts, the coefficient for the whole train K_t, will be (from Test No. 26)

$$K_t = 0.1575 + (0.0408 \times 2.8) = 0.1575 + 0.1142 = 0.2717$$

and the resistance formula of the one-member form is

$$R_a = 0.2717V^2$$

If the locomotive is longer than 100 ft. and a more accurate figure is desired, the excess length should be added to length of the four cars. If there were a bulge between the tender and the first car, or if there were a tail car, corrections K should be added or deducted, as the case may be. No corrections for locomotive noses, boiler tops, or shrouds (K_7, K_8 and K_9) should be made, as this is already taken care of in the K of the locomotive in Table I. If the perimeter of the cars P_c be known, and a more accurate figure were desired, the increase in air-resistance coefficient per each 100 ft. of train length can be taken as $0.00136P_c$, or $0.00121P_c$, for open or closed skirts, respectively. Likewise, if the frontal area of the locomotive A_L be known, instead of K, a should be taken from Table I and the locomotive coefficient should be figured. Also in this case corrections K_7, K_8 and K_9 should be disregarded.

For standard locomotives and trains it was not so easy to find a consistent law, probably for the reason that the gaps between the cars introduce eddies and turbulence which cannot be represented by one formula. Furthermore, it should be said that models of standard equipment, which were used at the tests at New York University,[1] were of two different scales (1/16 and 1/32) and the two-member formulas for these equipments, when expanded to full scale, did not give identical results. This can be seen from Fig. 4, where points representing results of Tests Nos. 28 to 35, inclusive, are shown on a chart drawn to a larger scale.

The method of expanding the test results to full scale, which was so helpful for the study of the test results with streamlined equipment, was inapplicable to standard equipment. The power of 1.85 of the second member in formula [2] probably ought to be increased, coming closer to 2, which represents turbulent air flow better than 1.85. In our standard equipment, which has air gaps, turbulent flow probably predominates, and the extrapolation should be made more in relation to the square of the size S_c^2 than $S_c^{1.85}$.

The curve for the standard cars, shown in Fig. 4, corresponds to a formula

$$K_c = 0.00283P_c\,(L_c/100)^{0.80} \quad \ldots\ldots\ldots\ldots\ldots\ldots [18]$$

where P_c, the perimeter of the test cars used, is 37.83 ft.,

(Continued on page 140)

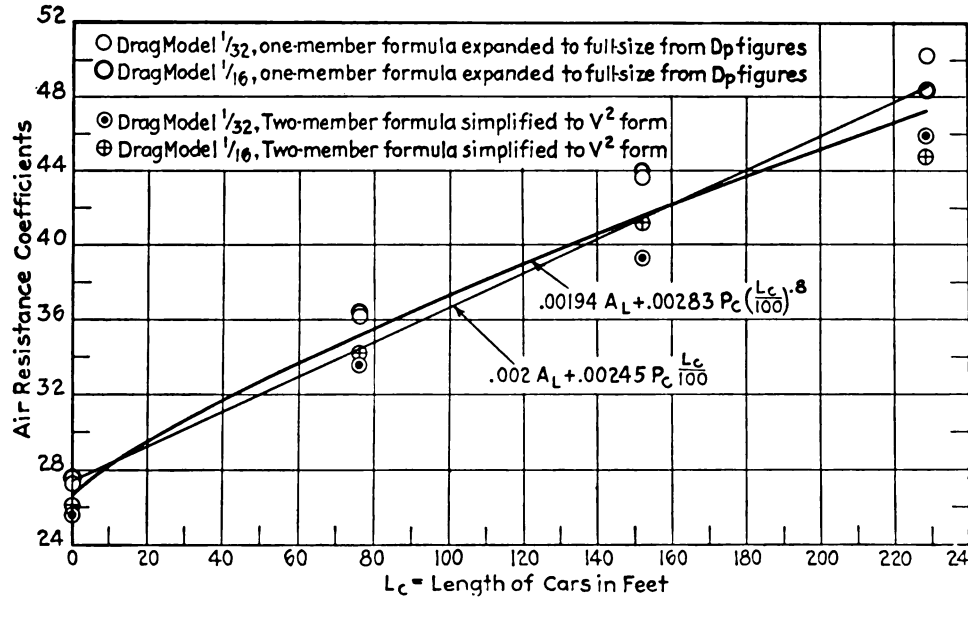


Fig. 4—Air-resistance coefficients of standard trains



D. & H. box cars of 40 tons nominal capacity have a cubical capacity of 3,378 cu. ft., and a load limit of 93,300 lb.

D. & H. Builds Lightweight

Welded Freight Cars

One experimental hopper car and 100 box cars all of 40-tons capacity built partially of alloy steels—Reduction in tare weight increases capacity to that of 50-ton cars—Innovations introduced in the body side construction of the box cars

THE D. & H. recently completed the construction of 100 all-steel box cars of 40 tons nominal capacity and having a cubical capacity of 3,318 cu. ft. Of this order, all of which were built in D. & H. shops and are now in service, 75 are of riveted and welded construction, 10 are of all-welded construction, and 15 are all-welded with the exception of the ends which are only partially welded to the roofs and are riveted to the sides and end sills. The sides for all the cars were prefabricated at the shops of the Greenville Steel Car Company, a subsidiary of the Pittsburgh Forgings Company, and shipped to the D. & H. shops. The doors, with Camel roller lifting fixtures, were supplied by the Youngstown Steel Door Company. Dreadnought steel ends were shipped to the D. & H. shops and welded there, after which all safety appliances were riveted in place. Chicago-Hutchins dry-lading roof sections were also assembled and the cap seams were riveted at the D. & H. shops.

In these cars, high-tensile alloy steels were used in the principal sections of the underframe, which permitted some reduction in tare weight. The principal proportions of the car are given in Table I.

Innovations in Side Construction

In the last five cars some interesting features in body side construction were introduced by the Greenville Steel Car Company. These sides comprise sheets of 0.10-in. steel with channel shaped vertical ends 1¾ in. in depth. The steel posts are ¼-in. by 3-in. by 3-in. tee shapes with flanges on the inside, the web end being flush with the outside sheets. Fabrication of the sides was accomplished by electric spot welding, the weld passing through the webs of the sheet channel sections and the web of the posts between the channels.

Of equal interest is the novel means of applying the inside wood lining in the spaces provided between the flanges of the side-sheet channels and the tee-shaped posts which combine to form grooves or slots into which the lining sections can be easily positioned. The lining, which is tongued and grooved, is 39½ in. long by 1½ in. thick by 3¼ in. wide, this size representing a departure from the conventional full-length pieces. The ends are milled to fit in the grooves previously described. Each piece is applied from the top. Finally, the top piece is secured in position by means of a stud and nut, welded to the side plate, which provides a means for keeping the lining tight at all times; no nails whatever are used.

Table I—Principal Proportions of 95 of the 40-Ton Box Cars

Length inside, ft. and in.	40–6
Length over striking castings, ft. and in.	41–8½
Truck centers, ft. and in.	30–8½
Width inside, ft. and in.	8–9⅛
Height inside at eaves, ft. and in.	9–4¼
Height from rails over running board, ft. and in.	13–9$^{11}/_{16}$
Capacity, level full at eaves, cu. ft.	3,318
Light weight, lb.	41,000
Ratio of pay load to gross load, per cent	69.8

The side sill is formed in the shape of the letter "W" which permits welding of the posts on the 5⅛- in. vertical section of the side sill. With this type of side, the inside width of the car was increased by 1.825 in.

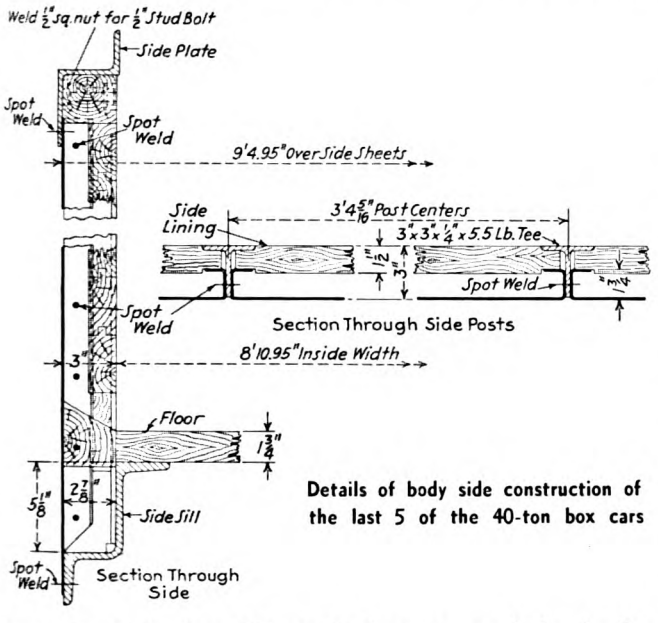
This side construction was adopted by the D. & H. because (1) it is believed that it possesses adequate strength, (2) it is found that spot welding eliminates to a large degree the buckling of sheets encountered by

other methods, (3) by the application of heavier lining, 1½ in. thick, the car is more desirable from a shipper's standpoint as it provides a more solid side for nailing and bracing lading, and (4) the heavier lining will reduce maintenance expense as it will better withstand wear and tear. The principal proportions of the last five cars built are given in Table II.

Other Construction Details

A. A. R. double Z-section center sills of the U. S. S. Man-Ten steel continuously welded at the junction of the two flanges are employed in the construction of all the cars. All bolster webs, crossties, cross-bearer webs and the side sheets are of copper-bearing steel. All other parts are of carbon steel.

The trucks have integral cast-steel side frames for 5-in. by 9-in. journals. The bolsters are cast steel. A. A. R. springs are used with one Frost or Miner truck-spring snubber in each spring group. Truck construction includes Creco four-point brake-beam supports, and A-Zee brake-hanger suspensions. The cars are also equipped with Kass metal brake steps, Ajax



Details of body side construction of the last 5 of the 40-ton box cars

power hand brakes, Miner draft gears, and A. A. R. bottom-operated Type E couplers furnished by the National Malleable and Steel Castings Company and fitted with Union Metal Products centering devices. All cars are equipped with type AB brakes.

The interior of the cars are wood lined, with the exception of the roof; however, before the cars were lined, a heavy coat of Continental cement was applied for a height of 2 ft. on the ends and sides of the interior. After lining, the wood was sand papered and the sides sprayed with a coat of enamel and the floor sprayed with Balcolac. The outside of the roof was sprayed with two coats of Valdura after the inside and outside of the roof had been sprayed with one coat of galvanized-iron primer. All painting, including stenciling, was done by the spray method.

Experimental 40-ton All-Welded Hopper Car

The D. & H. has had in service for a little more than a year an experimental all-welded self-clearing hopper car of 40-ton nominal capacity and with a tare weight of 32,700 lb. This light weight was secured by welded construction, the use of lightweight alloy steels, and unusual design features as well as the use of integral-type cast-steel trucks with 5-in. by 9-in. journals. The capacity of the car is 1,752 cu. ft. when level full at the side sheets and 1,981 cu. ft. when loaded with a 10-in. uniform heap of coal. Although the car is stenciled 80,000 lb. capacity, it is capable of carrying 103,300 lb., this being the weight after 32,700 lb., the tare weight, is deducted from 136,000 lb., the A. A. R. permissible total

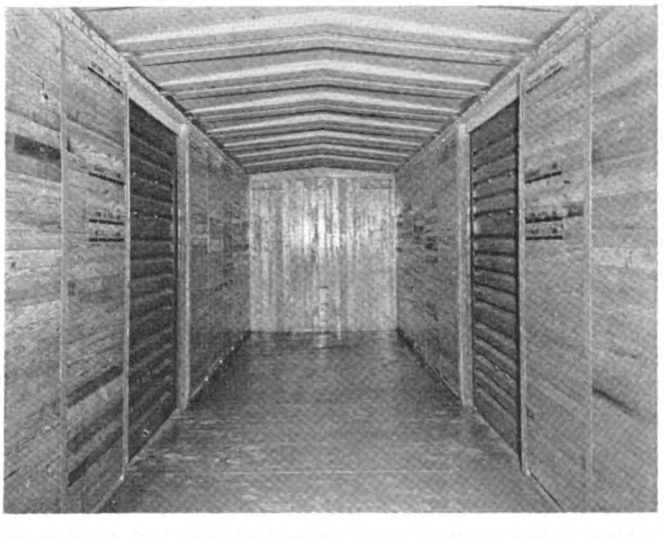
Table II—Principal Proportions of the last 5 of the 40-ton Box Cars

Length inside, ft. and in.	40– 6
Length over striking castings, ft. and in.	41– 8½
Truck centers, ft. and in.	30– 8½
Width inside, ft. and in.	8–10.95
Height inside at eaves, ft. and in.	9– 4¼
Height from rails over running board, ft. and in.	13– 9 11/16
Capacity, level full at eaves, cu. ft.	3,378
Light weight, lb.	42,700
Ratio of pay load to gross load, per cent	68.6

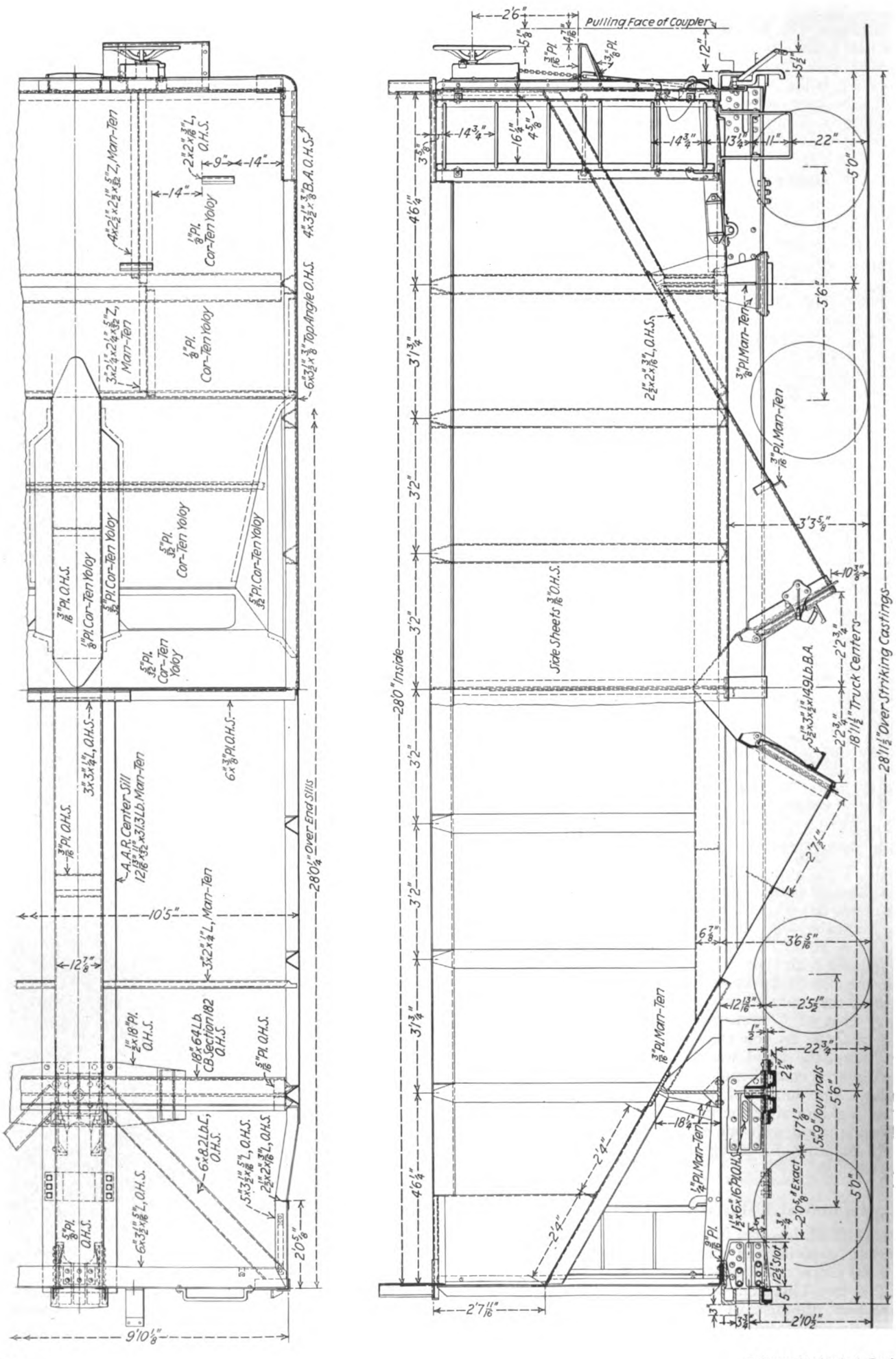
weight on the rails for a car with 5-in. by 9-in. journals. However, when carrying anthracite coal, the service for which the car was designed, it will carry a maximum load of 103,012 lb. when heap loaded to 1,981 cu. ft. Loaded thus with anthracite coal the car weighs 288 lb. less than the permissible load limit. Thus, by reducing the tare weight of the car with this cubical capacity, a maximum load of over 50 tons has been attained—a ratio of pay load to gross load of 75.9 per cent. The ratio of pay load to tare weight is 3.17 to 1. The design of the car is experimental, but its performance to date has proved its serviceability with the result that the D. & H. will probably adopt its design as standard for future construction of similar cars.

The reduction in tare weight was made possible through the use of alloy steels, welding fabrication instead of riveting, and unusual design features. One of these features is the elimination of the usual type of body bolster which is replaced by an 18-in. I-beam weighing 31.3 lb. per ft. placed on top of the center sills. Side-bearing supports built up of U. S. S. Man-Ten steel plates are welded to this I-beam and are braced from the bottom of the center sill; the bearing surface is composed of a ⅜-in. spring-steel plate. The top flange of the I-beam is bent close to the web to an angle of 30 deg. to act as the main support of the end slope sheets.

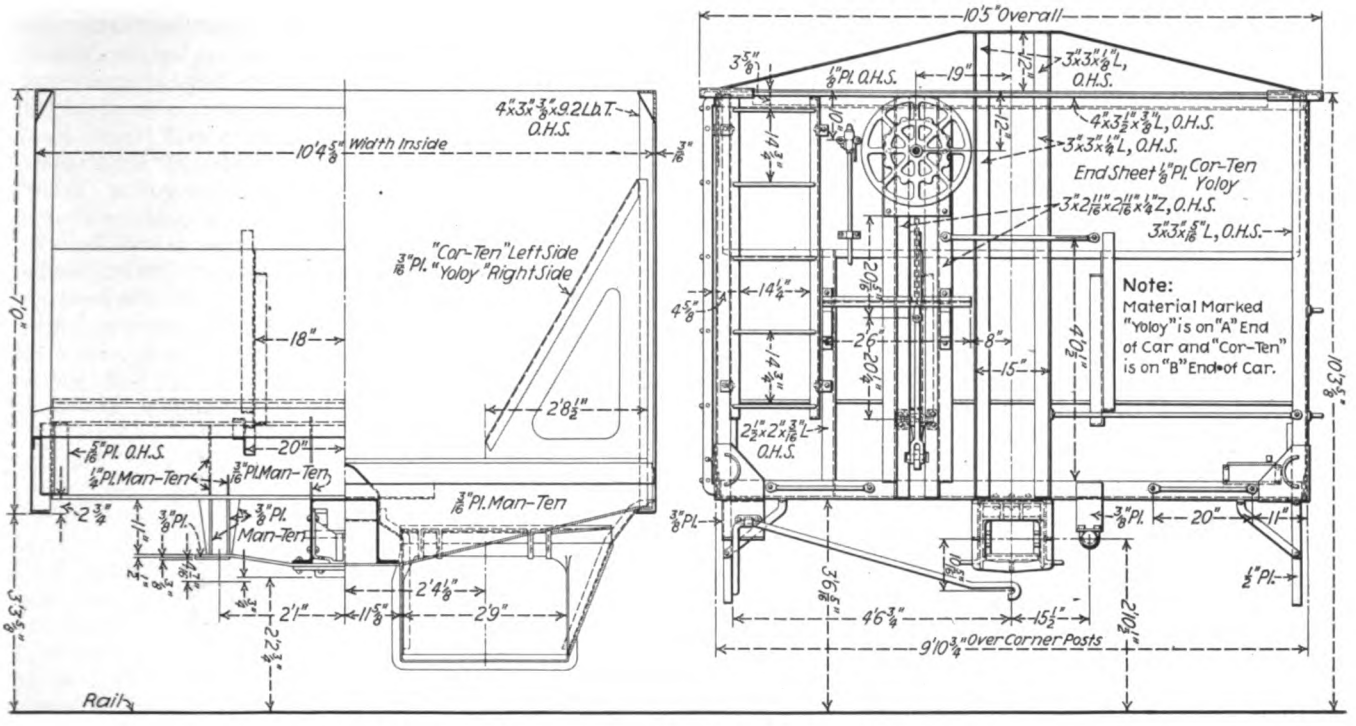
Another feature of the design is the inside integral V-shaped side posts. The V is formed at one end of each side sheet. The end of the adjoining sheet overlaps



The lining of the cars is made up of tongued-and-grooved pieces 39½ in. long, 3¼ in. wide and 1½ in. thick—No nails are used to secure the lining



Side elevation and plan view of the D. & H. experimental 40-ton hopper car



End elevation and cross-sectional view of the D. & H. 40-ton hopper car

the open side of the V, and when the sides were welded along both edges of the V a closed triangular-section post is formed.

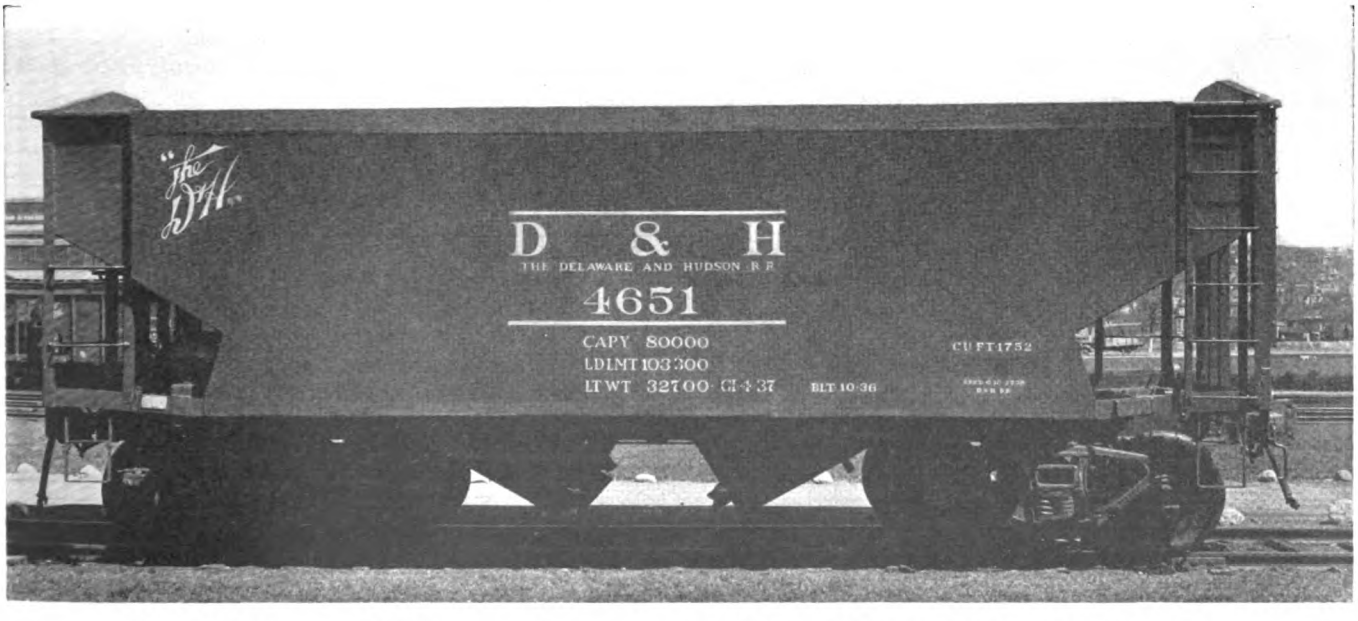
The center sills are formed of two A. A. R. Z-sections of U. S. S. Man-Ten steel joined by continuous welding at the junction of the two flanges. The body-bolster parts, cross bearers and floor stiffeners are also of the same material electrically welded. The slope and hopper sheets at the A end of the car are of Yoloy steel while those at the B end are of U. S. S. Cor-Ten steel. The side sheets, however, are of conventional carbon steel.

Table III—Principal Proportions of the 40-Ton Hopper Car

Length inside, ft. and in.	28– 0
Length over striking castings, ft. and in.	28–11½
Truck centers, ft. and in.	18–11½
Width inside, ft. and in.	10– 4⅝
Height from rails at side sheets, ft. and in.	10– 3⅝
Capacity, level full at side sheets, cu. ft.	1,752
Capacity, with 10-in. uniform heap load, cu. ft.	1,981
Light weight, lb.	32,700
Ratio of pay load to gross load, per cent	75.9

It has been the experience of the D. & H. that the side sheets of all-steel hopper cars have an average life of 17 years, whereas the slope and hopper sheets last about 12 years. From a car maintenance point of view it would be ideal to renew these major parts at one shopping, and therefore one of the objectives sought with this car is to extend the life of the parts that failed in 12 years and establish a comparable service life for all major sections. In furtherance of that end, the hopper unit is strengthened by the application of Wine cast-steel hopper frames, cast-steel doors and door locks.

Other items of interest on this car are the AB type



All-welded hopper car of 40 tons nominal capacity with a load limit of 103,300 lb. and a weight of 32,700 lb.

brake equipment and Ajax power hand brakes. A significant feature of the car is the relatively few parts used in its construction; there are only 1,153 parts, of which 601 are bolts, nuts and rivets, as compared with 3,596 parts in the conventional hopper car of this capacity. The use of welded, instead of riveted, construction is responsible for most of the saving since there are only 277 rivets in the entire car as compared with 2,576 in the U. S. R. A. 55-ton hopper car.

The D. & H. has experienced considerable demand from the anthracite coal fields for a car with twin hoppers having a capacity of 50 tons. This experimental car has therefore been favorably received since it has the required capacity and is entirely self-clearing with the hopper spacing so arranged as to effect unloading in one spotting of the car. The principal proportions of this all-welded hopper car are given in Table III.

The truck side frames were furnished by the Adirondack Steel Company with 5-in. by 9-in. journals and, with journal boxes cast integral, there is a saving in weight as compared with side frames and larger journals. The wheels are 750-lb. chilled-iron single-plate, A. A. R. standard made by the Albany Car Wheel Company. The springs are A. A. R. standard with one Frost friction unit in each spring group. Truck bolsters are of cast steel. Truck brake rigging, brake beams, brake shoes, hangers and other parts conform to A. A. R. specifications. The car is also equipped with metal brake steps, Miner draft gears, and alloy-steel A. A. R. Type E couplers with 6¼ in. by 8-in. shank, bottom operated, furnished by the National Malleable and Steel Castings Company.

Causes and Remedies of

Slagging and Honeycombing

ONE problem which has come before the Railroad Smoke Association of Hudson County, N. J., persistently at its monthly meetings, has been that of the formation of slag and honeycomb. Eventually it was decided to appoint a special committee to make a thorough study of it. The report of this committee was made at the February meeting of the Association, together with a minority report by William G. Christy, which does not take issue with the majority report, but, rather, amplifies certain features in it.

The report opens with certain general observations and then, under various heads, discusses the causes and remedies for slagging and honeycombing. The two reports, somewhat abridged and rearranged, follow:

Majority Report

Slag contains iron in some form combined with a percentage of silicon and ash. The formation of slag is developed by any condition that retards combustion, causing temperature changes which will not produce enough heat to convert the mineral particles of fuel into non-fusible substances.

Honeycomb differs from slag inasmuch as the iron content is lower, with increase in the percentage of silicon and ash, and is caused chiefly by any condition that shortens the time element of combustion.

The fusing point of ash and clinker may be divided into three stages—the initial point, the softening point, and the fluid point. The temperature range depends upon the constituents and may cover from fifty to several hundred degrees F. for any given fuel, and ranges from perhaps 1,800 to 3,000 deg. F. for different fuels. Any decrease in temperature after fluidity has been attained will naturally tend to affect the density and hardness of the clinker form.

The rate of burning has a definite bearing on the percentage of clinker formation in the ash. The highest percentage of clinker formation was found by Fieldner, Selvig and Nicholls, to occur at a rate of burning of 20 to 30 lb. per sq. ft. per hour. The quantity of clinker decreases as the rate of burning increases, although density and fusion are greater at higher rates. The rate of decrease of quantity of clinker becomes less for low ash fusion temperature. Escape of gases through prolonged high temperature permits the formation of less brittle clinker.

Design of Locomotive

Each class of locomotive is designed for a predetermined rate of work, and the proportions between heating surface, grate area and flue area must be governed by the class of service. When this rate of work is exceeded, the fuel bed is disturbed by the increase in draft and supply of oxygen to the fuel bed. When this occurs, small particles of plastic ash are picked up by the flow of gases and adhere to metal surfaces, causing slag formations.

Remedy: Do not load the locomotive above its rated capacity.

Coal

The presence of iron in pyritic form or lime, in sufficient quantity, causes honeycombing or slag. Coals with high iron content and low fusion point present the greatest problem. Pyritic iron undergoes a chemical change at 800 to 900 deg. F., becoming ferrous sulphide. It adheres to small pieces of unburned fuel and is carried along by the draft, being thrown against the surface of the staybolt heads and flue sheets in this semi-pasty condition. Then heat drives off the volatile and combustible matter, leaving ash as honeycomb.

Too large a proportion of fines in the coal also causes trouble.

High percentages of iron or lime in the coal cause low melting points (1,800 deg. to 2,000 deg. F.), while alumina and silica raise the melting point from 2,600 to 3,000 deg. F. (Ref.—Kent, Vol. 2, 11th edition). High silica and alumina ash are not readily fusible, and usually ash low in iron and lime has high silica and alumina. Coals high in sulphur will generally clinker readily. Ref.—Transactions, A. S. M. E., FSP-50-60, 1928. Fieldner, Selvig, and Nicholls.)

Remedies: Give special attention to selection of fuel, watching out for pyritic content. Select coal with minimum amount of sulphur and iron pyrites. Wet down fine coal. Select coals which will meet the requirements of the service, will be within certain prescribed limits, and will have uniform quality.

Firing of Locomotive

Uneven fuel distribution over the grates will cause thin spots or holes. The rate of combustion increases at

these spots, the temperature rises, and the increase in the velocity of the gases in such locations picks up small particles of plastic ash which deposit on the metal surface and multiply into slag formations. Other causes of slag and honeycombing are banking back corners; forcing fires, thus shortening the time element of combustion; heavy firing, and high rate of combustion per square foot of grate area.

Remedies: Follow good firing practices; distribute coal evenly to the fuel bed; maintain a uniform thickness of fuel bed; avoid banking; avoid heavy firing. In general, a clean, bright, level fire, as thin as possible, over the entire grate level, is at all times the most economical and will assist in reducing slag formations to a minimum.

Operation of Locomotive

Several factors in locomotive operation are responsible for slag and honeycombing. Among them are slipping of drivers, which increases the velocity of the gases and shortens the time of combustion; foaming or priming which increases weight of exhaust steam; abnormal high water conditions; improper operation of throttle, reverse gear, boiler feed, etc.

Remedies: Watch the water level; avoid sudden opening of throttle and slipping; when foaming or priming occurs, follow railroad company's instructions; assure lubrication of valves, cylinders, pumps, etc.; enginemen and firemen must work together to produce results, conserve coal and reduce smoke.

Drafting of Locomotive

Causes of difficulty are restricted air space in the ash pan; excess openings in the grates; smokebox leaks, and holes in or misalinement of stack, draft pipe, exhaust nozzle and netting. An improperly drafted locomotive will cause slag formation.

Remedies: Avoid loose fitting or broken valve rings and piston rings, both of which impair front-end vacuum. The exhaust nozzle plays an important part in the operation of the locomotive. Its size is usually specified in the design. Tests should be made by the responsible department under varying loads and when the proper size is determined, all locomotives of a class should be equipped with the same size nozzle and no changes in size made without proper authority. The design of lift pipe and stack should be such that the exhaust will fill the stack and produce proper vacuum to obtain a uniform flow of gases through the tubes.

Maintenance of Locomotive

Causes of slag and honeycombing are leaky superheater units; leaks in the firebox or flue ends; plugged flues; heavy or rough beads on flues; mud and scale in the boilers; condition of the brick arch; defective grates. The maintenance forces play a large part in reducing slag formation. Improper maintenance can be responsible for honeycomb and slag formations.

Remedies: The locomotive must be properly prepared; keep the firebox or front end in proper condition; avoid smokebox leaks; clean flues periodically; replace defective grates; check alinement of stoker distributor plates and stoker jets.

The maintenance forces should see that no firebox leaks exist, that flues are clean and in proper condition, that the smokebox is free of air leaks, and that the exhaust pot base is in line and properly fastened.

A proper schedule of work covering all parts at the boiler-wash period will keep the locomotive in condition through its life between class repair periods, and reduce the daily maintenance. Experience has demonstrated that this method of repairs, and the assignment of locomotives to individual enginehouses for periodic work, reduces delays and trouble from slag formation.

The report was signed by C. K. Keiser, assistant superintendent motive power, Pennsylvania; G. W. Rink, mechanical engineer, Reading Company; T J. McDermott, mechanical engineer, D. L. & W.; E. H. Fezandie, professor of mechanical engineering, Stevens Institute of Technology; and William G. Christy, smoke abatement engineer, Hudson County.

Minority Report

William G. Christy, smoke abatement engineer, Hudson County, made a supplemental report from which the following extracts are taken.

Water treatment results in much cleaner boiler conditions and a decided decrease in boiler maintenance work. The use of feedwater as free as possible from scale forming elements, should be a contributing factor in keeping down slag and honeycomb.

At our June meeting, Henry Kreisinger, Combustion Engineering Company, made the following statement: "Building the fuel bed wrong and starting it wrong, is probably a great factor in making the tube sheet slag." Certainly, if the fire is not started properly, and the fuel bed built up correctly in the beginning, it is naturally more difficult to get the fire in the proper condition. It would appear that if we start with fuel bed conditions right, this will help in eliminating the trouble with slag and honeycomb.

At the May meeting, W. L. Gorton, fuel supervisor of the Erie, put this down as one of the causes: "Running engines too far without dumping for cleaning out, especially when using coal of high sulphur content." I do not know how big a factor this is, but it seems to me it should be mentioned.

The question of sealed or unsealed arches has been discussed at length. We all know there is a difference of opinion as to just which is the best type of arch. It seems to me that the majority of the opinions expressed showed that there was less trouble with flues plugging up when there were at least some openings at the bottom of the arch. If we can keep the flues from plugging, this should certainly be one way to help in preventing slag formation.

In extensive investigations Henry Kreisinger has found that particles of unburned or partly burned coal are carried along with the gases, together with sticky ash, and are deposited on the flue sheets or tubes. These particles continue to burn after they are deposited and for a short time the temperature actually increases. This, undoubtedly, makes the slag condition worse. To my mind, poor combustion, or incomplete combustion, is one of the causes of our trouble. Anything we can do to get better, or more complete combustion, will be of material help.

The CO_2 which goes up to about 12 per cent in its passage through the fuel bed is reduced to 8 per cent when the top of the fuel bed is reached. Theoretically, it should increase to 16 or 17 per cent (ideal conditions), but instead, it is reduced. Coming off the top of the fuel bed we have unburned gases principally in the form of CO and methane. We must have oxygen to burn these gases. This means getting air over the fire in some manner. To do this properly in a locomotive, we may have to redesign the firebox. We must never lose sight of the fact that both turbulence and oxygen are two of the very essential elements of complete combustion. To get turbulence, we need air at high velocity over the fire. All modern stoker installations in stationary plants have over-fire air provided.

According to Mr. Kreisinger, the gases coming off the

top of the fuel bed contain something like 15 to 17 per cent of combustible gases. This is true, regardless of the thickness of the fuel bed and regardless of the rate of burning coal. Tests at the Bureau of Mines were made at fuel burning rates varying from 3 lb. to 185 lb. of coal per sq. ft. of grate per hour. When you try to force more air through the fuel bed, instead of getting 14 or 15 per cent CO_2 and no combustible gases at the top of the fuel bed, the rate of combustion, or the rate of burning the fuel, is just increased. The percentages of CO_2 and unburned gases remain about the same. This is something to which we should give serious consideration.

C. M. St. P. & P. 4-8-4 Freight Locomotives

(Continued from page 128)

Low water alarm	Barco Manufacturing Co., Chicago
Steam-heat gage	Ashton Valve Co., Boston, Mass.
Steam-heat stop valve; steam-heat reducing valve	Vapor Car Heating Co., Inc., Chicago
Typhon horn	The Leslie Co., Lyndhurst, N. J.
Chime whistle	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Bell ringer, King type	U. S. Metallic Packing Co., Philadelphia, Pa.
Cab signals with air whistle	Union Switch & Signal Co., Swissvale, Pa.
Sanders	Morris B. Brewster Company, Chicago
Coal sprinkler hose	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Fuel sprinkler	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Headlight; generator, Type E-3-LA	Pyle-National Co., Chicago
Cylinder cocks	T-Z Railway Equipment Co., Chicago
Cylinder and steam chest bushings; valve bull rings and sectional combination iron and bronze packing rings	Hunt-Spiller Manufacturing Corporation Boston, Mass.
Piston rods	Standard Steel Works Co., Burnham, Pa.
Piston-rod and valve-stem packing, Diamond Crescent	T-Z Railway Equipment Co., Chicago
Piston bull rings and combination iron and bronze packing rings; outer rod bushings	Hunt-Spiller Manufacturing Corporation Boston, Mass.
Reverse gear	(15) The Baldwin Locomotive Works, Philadelphia, Pa. (15) American Locomotive Co., New York
Engine bed	General Steel Castings Corp., Eddystone, Pa.
Crank pins	Standard Steel Works Co., Burnham, Pa.
Engine truck and trailer wheels	American Steel Foundries, Chicago Standard Steel Works Co., Burnham, Pa.
Driving-wheel centers; Boxpok; driving axles; front engine-truck axles	Standard Steel Works Co., Burnham, Pa.
Engine truck (inside bearings)	General Steel Castings Corp., Eddystone, Pa.
Roller bearings	The Timken Roller Bearing Company, Canton, Ohio
Roller-bearing units	American Steel Foundries, Chicago
Trailer truck, Four-wheel Delta	General Steel Castings Corp., Eddystone, Pa.
Trailer tires	American Locomotive Co., Railway Steel Spring Div., New York
Springs, engine and coil	American Locomotive Co., Railway Steel Spring Div., New York
Brake, No. 8ET	Westinghouse Air Brake Co., Wilmerding, Pa.
Lateral motion device; Slid-Guide attachment	American Locomotive Company, New York
Unit Safety drawbar and Type E-2 radial butter	Franklin Railway Supply Co., Inc., New York
Lubricators:	
Left side, unlagged	(15) Detroit Lubricator Co., Detroit, Mich. (15) Ohio Injector Co., Wadsworth, Ohio
Right side, lagged	(30) Nathan Manufacturing Co., New York
Lubrication	Alemite Div. Stewart-Warner Corp., Chicago
Lubricator, flange	Morris B. Brewster Company, Chicago
Force-feed pump lubricators	Westinghouse Air Brake Co., Wilmerding, Pa.
Air pump line and generator supply and operating valves	Walworth Company, New York
Flexible metallic conduit between engine and tender	Barco Manufacturing Co., Chicago, Ill.
Tender:	
Rectangular water bottom	General Steel Castings Corp., Eddystone, Pa.
Truck frames	General Steel Castings Corp., Eddystone, Pa.
Wheels	(16) American Steel Foundries, Chicago (14) Standard Steel Works Co., Burnham, Pa.
Axles	Standard Steel Works Co., Burnham, Pa.
Roller-bearing units	American Steel Foundries, Chicago
Roller bearings	SKF Industries, Philadelphia, Pa.
Journal boxes	National Malleable and Steel Castings Co., Cleveland, Ohio
Springs	American Locomotive Co., Railway Steel Spring Div., New York
Side bearings	A. Stucki Co., Pittsburgh, Pa.
Coupler, A. A. R.	Buckeye Steel Castings Co., Columbus, Ohio
Uncoupling rigging, Imperial type B	Union Metal Products Co., Chicago
Draft gear	W. H. Miner, Inc., Chicago
Simplex unit cylinder clasp brake	American Steel Foundries, Chicago
Tank steel	Bethlehem Steel Co., Bethlehem, Pa.
Tank valves, tank hose coupler and strainer	T-Z Railway Equipment Co., Chicago
Tank hose	Hewitt Rubber Corp., Buffalo, N. Y.
Tank drain plugs	The Prime Manufacturing Co., Milwaukee, Wis.
Water-level indicator	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Back-up lamp	Pyle-National Co., Chicago

Air Resistance Of Trains

(Continued from page 133)

and L_c is the length of the car portion of the train.

It is evident from Fig. 4 that a straight line corresponding to a formula

$$K_c = 0.00245P_c\ (L_c/100) \quad \text{.....[19]}$$

would still be within the region of the quadruple points and, according to what was stated previously, could be justified as a coefficient for standard-car resistance.

Regarding the intersection of both the curve and straight line with the vertical ordinate line corresponding to zero length of cars, the first, for locomotive and tender alone, is $K_L = 0.266$, corresponding to $a = 0.00194$, and the second to $K_L = 0.274$, corresponding to $a = 0.002$, which is very close to the foregoing and is exactly the coefficient given by Cole in the Locomotive Handbook.[5] Thus, for standard locomotive and standard cars, the simplified formula

$$K = 0.002A_L + 0.00245P_c\ (L/100) \quad \text{.....[20]}$$

can be applied, where A_L = frontal area of the locomotive, sq. ft.; P_c = perimeter of the car from plane of top of rails over car to plane of rails on the other side of the track, ft.; and L_c = length of the car portion of the train, ft.

Therefore, the simplified formula for the air resistance of the standard train is

$$R_a = [0.002A_L + 0.00245P_c\ (L_c/100)]\ V^2 \quad \text{.....[21]}$$

In the opinion of the author formulas [20] and [21] have the same justification as the formulas which include exponential values of L, but he would not recommend the extrapolation for longer standard trains of either of the two until further wind-tunnel tests or data from actual tests are available. Formulas [20] and [21] have the advantages of being simpler, and in the light of the foregoing speculations, these two formulas should be given preference. Formulas [10], [11], [13], [14] and [21] are recommended by the author for air resistance of streamlined, power car, and locomotive-driven trains, and trains of standard cars driven by standard locomotives.

[5] "Locomotive Handbook," American Locomotive Company, New York, N. Y., 1917, p. 20.

EDITORIALS

Lightweight Driving Parts Needed

In a paper discussing the general subject of rail damage and the relation of locomotives thereto, D. S. Ellis, chief mechanical officer, Chesapeake & Ohio, said at the March meeting of the Western Railway Club that, with modern high operating speeds, particular attention must be paid to locomotive design details to minimize dynamic augment as affected by the following factors: (1) Underbalanced reciprocating weight; (2) unbalanced revolving weight; (3) couples produced by piston thrust on the crank pins and by lateral differences in the vertical planes of reciprocating weights and their counterbalances in the wheels; (4) variations in wheel loads due to static weight, spring deflection with consequent load transfer, center of gravity, and rail elevation.

As regards the possibility of reducing the weight of reciprocating parts by the use of high-tensile alloy steel vs. plain carbon steel, Mr. Ellis quoted figures for two different classes of 4-4-4 type locomotives in which the reciprocating weights were reduced from 870 lb. to 798 lb., or 8.3 per cent, for one locomotive, and from 1,090 lb. to 1,003 lb., or roughly 8.0 per cent for the other locomotive. The corresponding reductions in dynamic augment were 7.7 per cent for one locomotive, and 10.9 per cent for the other. Mr. Ellis strongly urged the instruction of mechanical-department supervisors and mechanics in the proper use and treatment of the alloy-steel locomotive motion work parts if satisfactory results are to be secured.

Fewer Car Loads Transferred at Chicago

What can be accomplished through co-ordinated efforts in solving a more or less difficult problem is well illustrated by the results attained in reducing the number of freight-car loads transferred in the Chicago district due to defective equipment. In 1924, almost 12,000 car-load shipments were transferred at this terminal on account of being loaded in equipment which was unfit to run. At an estimated transfer cost of $25 per car, exclusive of claims, this represented a loss of practically $300,000. An intensive drive, sponsored by the Chicago Car Interchange Bureau, brought both shippers and railroad car inspectors to realize the seriousness of this loss, and the number of car loads transferred was gradually reduced, year by year, until a record was reached of only 52 cars in 1935, this number subsequently increasing to 104 cars in 1936 and 108 cars in 1937. In the latter two years adjustments of loads on open-top cars on account of non-compliance with A. A. R. loading rules increased from 377 to 616.

One of the most effective remedies adopted to reduce load transfers was the development of mobile repair units which enabled the Chicago bureau to make load adjustments without necessitating the handling of defective cars to the repair tracks. The desirability of further extension of this work and also educational efforts among shippers and car inspectors is shown by the slight increase in load transfers and adjustments in 1936 and 1937, an increase which is only partly chargeable to the increased number of revenue cars handled through the terminal. Since the total cost of transferring cars includes not only a direct average labor charge of approximately $25 per car, but extensive damage claims due to the extra handling of materials, delays of 12 to 36 hrs. in reaching the market, etc., it is evident that too much care cannot be exercised in making sure that, so far as possible, every car loaded is in suitable condition to proceed to destination and that the shipment is loaded in strict accordance with the A. A. R. rules.

Inadequate Enginehouses Hamper Operation

Modern motive power with all of its refinements is relatively expensive to buy and, to secure a maximum return on the investment, requires a high continuity of service and minimum time away from its regular assignment. A large percentage of locomotive out-of-service time is chargeable to conditioning operations at engine terminals and, regarding this phase of locomotive maintenance, W. J. O'Neill, superintendent of motive power, Western Pacific, recently made some pertinent comments.

In a paper before the November meeting of the Pacific Railway Club, Mr. O'Neill said: "Speaking of maintenance, mechanical forces have handled and are still handling modern locomotives in enginehouses that were built for smaller power. Stalls and pits are too short; doors cannot be closed because tanks extend out over the pits; and, in order to drop driving wheels, the tenders must be cut off so as not to block the track on each side. Stalls and pits of the proper length, drop pits or drop tables for engine-truck, driver, trailer and tender-truck wheels should all be considered, including suitable shop equipment and machine tools to handle

all kinds of enginehouse repairs. Railroads should consider these as they do laying heavier rails, enlarging tunnels, strengthening bridges, ballasting track, and providing longer and larger tables."

In further emphasizing the need for adequate drop pits, Mr. O'Neill said: "Enginehouses that have Whiting drop pits, or hoists, or other similar devices of modern construction are very fortunate. These greatly facilitate dropping all locomotive wheels. Railroad executives must listen to the pleas of their enginehouse foremen for modern enginehouse facilities and grant the expenditures necessary for these, otherwise locomotives cannot earn a fair return on the investment due to the fact that they are off duty too much of the time while antiquated enginehouse equipment is being used to condition them for further service."

While many intermediate enginehouses have been closed and marked improvements effected at certain others, a large number are still quite inadequate to condition and turn modern motive power with the promptness essential to efficient operation. The question may be asked: Why are not necessary improvements made? The presiding officer at the meeting referred to said that this question reminded him of one once put to a candidate for a job as policeman. In the oral examination given this Irishman, he was asked, "What are rabies and what can be done about it?" to which he replied "Rabies are Jewish priests and nothing can be done about it."

In the present state of railway finances, it is largely true that "Nothing can be done about it," except possibly to study conditions thoroughly and develop careful estimates of cost savings which can be effected by the installation of improved enginehouse facilities and equipment when business conditions improve. In the meantime, enginehouse forces, including both supervisors and workmen will continue as they have in the past to exercise notable ingenuity, resourcefulness and good mechanical judgment in getting the best results with enginehouse facilities available.

The Payroll Distribution

Comment is occasionally heard from railway employees, in the ranks of the mechanical department and elsewhere, indicating resentment at the fact that some railway officers have been paid salaries as high as $100,000 per year. Such comments imply that, if the executives were paid only what they were worth and all of the other employees were paid what they actually earned, the railroads would be much better off and presumably so would the employees.

The question of the fairness of the distribution of compensation among railway employees for their labor is not one which can be discussed in absolute terms; it can be discussed only in relative terms. There is no basis on which to determine positively just how much a railway executive of wisdom and ability may be worth to the owners of the property which he manages, to its employees and to the public which it serves. It hardly seems probable that any specific figure, either below or above $100,000 per year, can arbitrarily be set as marking the limit beyond which, under all circumstances, a corporation will be paying more than the right man in the right place is worth.

But it is not the purpose of this discussion to consider that point. It is proposed here to bring out certain facts which, from the standpoint of the greater proportion of railway employees, are more pertinent in relation to the dissatisfaction many of them from time to time feel with their lot. The first fact is that the question of what should constitute the limit of executive salaries is of purely academic interest. On August 1, 1937, an increase in pay amounting to five cents an hour became effective for approximately 800,000 nonoperating railroad employees. This has been estimated to involve an additional payment of $98,000,000 a year in wages to those employees—an average of about $120 to $125 a year per person.

It would be extremely difficult, if not impossible, to determine statistically how much could be saved if the salaries of all executive officers were limited to any specific figures. Let us assume, therefore, that the railroads were to dismiss all of their executive officers (those whose salaries are charged to general expense), including presidents, some vice-presidents, the accounting officers and corporate officers, so that their complete salaries and expenses were available for other purposes, and then let us assume that the amount thus saved were to be distributed among the 800,000 nonoperating employees. Each of these employees would receive a further increase of $19 per year, or $1.58 per month. It is obvious that an even more insignificant amount would be involved if there were available only the amount of "excessive" salary received by the higher-paid executives, no matter how the term "excessive" might be defined.

As a practical matter, therefore, employees among the 800,000 who are dissatisfied with their lot will have to look elsewhere than to the "excessive" compensation of railway executives as a possible source of wage readjustment. On October 1, 1937, an increase in pay of 6.6 per cent became effective for the train-service employees. For the 254,000 employees in these groups the amount of this increase was estimated at about $35,000,000 per year, or an average of $135 to $140 per year per person.

But during the past five or six years the road-service groups have, in effect, already acquired a gradual increase in compensation as the result of the growing spread between the time for which they are paid and the actual time worked. For 1937 this spread amounts to one-third in the average rate per hour of all road-service trainmen and enginemen. This leaves out of con-

sideration all compensation for overtime and constructive allowances. Thus, road passenger conductors, whose rate for the straight time paid for averaged 97 cents per hour during 1937, were actually paid an amount which equals $1.54 per hour of straight time actually worked—a difference of 59 per cent. On the same basis, road passenger enginemen, whose straight-time rate per hour paid for was $1.32 an hour, actually received $1.91 an hour for the straight time actually worked, a difference of 44½ per cent. The 160,000 road-service train and engine employees, with an average rate of 86 cents per hour of time actually paid for, were paid at the rate of $1.16 per hour of time actually worked.

The straight time for which these 160,000 highly privileged employees were paid, but for which they did no work cost the railroads $83,000,000 in 1937. This is 84 per cent as much as the amount required to meet the recent increase of the 800,000 non-operating employees—about 4 cents an hour or better than $100 a year for each of them.

Impressive Advances In the Welding Art

A study of the trends of application of metallic arc welding reveals that the impressive advances made in this art have affected many economies in the maintenance of motive power and rolling stock, as well as in the construction of rolling stock. Welding has ceased to be an incidental tool restricted to a limited field of minor applications, and has acquired the status of an essential fabricating method which is responsible for numerous long-range economies in the railway field.

It required some forty years of intensive study to make this process suitable for assembling structures in which safety and dependability is of vital importance. The great obstacle was that liquid steel, while passing through the arc, picked up harmful elements from the atmosphere so that the weld zone did not equal the full strength of the adjacent parent metal. This obstacle has been overcome by coated electrodes. It has become possible to deposit weld metal which is 100 per cent as sound and strong as the material which it joins. Thanks to this refinement in the process, the designing engineer can figure his weld as being the strongest portion of his structure instead of a zone of reduced strength as in the early days of the art. This development is the real basis of important design trends of recent years. The advantage gained by arc-welded construction with modern welding materials and control methods is that designing engineers are relieved of former restrictions and can make almost any disposition of metal which they desire in their structures.

Within the past few years, the railroads have made significant advances in the welding of rolling stock which, together with the application of high-tensile low-alloy steel and careful distribution of metal in the underframes and superstructures, have permitted considerable reduction in tare weight. Many of the recently built locomotives have been constructed with welding liberally applied to the firebox, combustion chamber and barrel courses. One experimental locomotive boiler, that on the Delaware & Hudson, is completely welded.

The composite result is a new order of achievement in production and maintenance of motive power and rolling stock, a movement which has progressed far enough to establish itself soundly and firmly. Although the coated electrodes cost more per pound than bare wire, their sales have increased in volume approximately 700 per cent since 1933. Engineers in charge of design and maintenance of motive power and rolling stock have been quick to realize the saving effected by the application of welding, and it is only reasonable to expect that this art will find even more extended use in the railway industry.

New Books

RESISTANCE TO HEAT CHECKING OF CHILLED IRON CAR WHEELS, AND STRAINS DEVELOPED UNDER LONG-CONTINUED APPLICATIONS OF BRAKE SHOES. *A report of an investigation conducted at the Engineering Experiment Station, University of Illinois, in cooperation with the Association of Manufacturers of Chilled Car Wheels, by E. C. Schmidt and H. J. Schrader. Published as Bulletin No. 298 of the Engineering Experiment Station, University of Illinois, Urbana, Ill. 50 pages, 6 in. by 9 in., paper bound.*

The investigation, the results of which are presented in this bulletin, was undertaken primarily to study the effects of long-continued applications of brakes upon the treads of chilled iron car wheels, particularly in regard to the development of heat checks, cracks, and brake burns. The secondary purpose was to determine the strains and the stresses set up in a wheel under such brake applications.

Repeated brake applications were made to six different wheels for a total of 5,400 travel-miles of brake application. These tests equalled the braking effect of a freight-car weighing 68 tons traveling at a speed of 15 to 25 miles per hour down grades as steep as 4 per cent. Each application was continued for a travel distance of 20 miles. It was found that brake pressures exceeding 3,000 lb. caused the wheel treads to show cracks of such size that the wheel would be discarded from service. The repeated tests, including 270 brake applications, showed that lower brake pressures did not damage the tread. Results of these tests throw new light upon wheel damage caused by mountain grades, and also by sticking brakes.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

But *It Is* a Business !

Twelve years' experience as railroad machinist left me with no business sense of profit and loss. Material charges, sources of supply, payrolls, overhead and accounting costs meant nothing to me. A mechanic, or a machine, was just something to get work done with. What little planning I did was for the purpose of making a record, or from just intense interest in the work, and many times just plain showing off.

Don't Antagonize Railroad Fans

The emotion aroused in a great majority of onlookers by the mere passing of engines and trains is clear proof that railroad equipment still has a very strong sentimental attraction for the general public, and it is distinctly up to the railroad managements to capitalize upon that fact to the utmost, even if such action involves a little extra "trouble," or a more courteous attitude toward so-called "nuisances." After all the railroads have been through in the last decade, and in view of the more or less gloomy outlook for the future, it would seem obvious that no possibility of acquiring new friends or of retaining old ones should be neglected. I know very well that those laymen who formerly showed more than ordinary interest in American railroad equipment and operation were too often regarded as inquisitive intruders and sometimes treated with positive rudeness. No valid excuse can be offered for the existence of such an attitude toward potential friends today. While it is true that people without a thorough understanding of the exigencies of railroad work will sometimes make unreasonable requests, such cases must be handled with tact; if ill feeling is to be prevented.

Cultivating the Younger Generation

Your indorsement of plant visitations, etc., by groups of school children should be pondered in some official circles. How many railroad officials grasp the real significance of securing and holding the enthusiastic support of the growing generation? Whenever and wherever the opportunity presents itself, these young people should be imbued with the idea that the railroads are not a decadent institution, in order to counteract the propaganda that flows ceaselessly from competitive sources. This propaganda has, unfortunately, already infected too many present-day grown-ups. If the infection can be spread to a majority of our future citizens, then indeed the cause of the railroads will be irretrievably lost. Some years ago, one of the English main lines began a campaign intended to awaken the interest and enlist the sympathy of "boys of all ages." In addition to running cheap excursions at intervals from various points on the system to the central locomotive workshops, this company has published a unique series of illustrated booklets dealing with its locomotives and various phases of railroad construction and operation. Approximately 200,000 copies of these have been sold at a price of 25 cents each. It is doubtful if any immediate pecuniary profit has been made on the publications, but who can estimate their ultimate value to the company?

Deep in the Rut

Perhaps the various departments have gotten into ruts so deep they can no longer see what the other fellow is doing, as it is readily apparent that acts to effect economy in one department can become the cause of excessive expense elsewhere. Have the specialized habits of years caused a wrong viewpoint?

What Do These Services Cost ?

There are two special services railroads are furnishing their patrons for which no extra charge is being made, and I have been wondering what their cost is per year to the railroads. One of them is air conditioning of railroad passenger train equipment. Don't you think it would be interesting if one could know what the total cost to a railroad per annum is for the maintenance per unit of equipment, equipped with air-conditioning apparatus? All the cost should be considered, including the expense of all employes—labor and material, expense accounts, etc., even to that of the special men assigned to engineer and supervise it. Another item I have in mind is furnishing special equipment for special loading, such as cement cars, automobile cars equipped with automobile loading devices, special container cars used for hauling dolomite, lime and other similar materials. What expense are these to individual railroads, including upkeep costs and the cost of cars lying idle waiting, because they cannot be used for other purposes? If the annual cost of these items were known, no doubt it would be helpful and would be useful many times. Shippers are obtaining the use of such equipment without any additional cost, and why should one shipper be furnished with special conveniences for his shipments and another denied, without any additional cost?

Special Attention Should Be Given to Cutting Tools

One very important factor in connection with machine tool operation in railroad shops receives too little attention. I refer to proper equipment and personnel adequately to take care of the heat treatment, repair and resharpening of cutting tools. In my opinion, every railroad shop should have a thoroughly trained heat treater. Many of the steel companies are more than willing to co-operate in training such a workman. Too often a "run of mine" blacksmith poses and is accepted as thoroughly proficient in this line of work. In all fairness to the blacksmith, unless he has made a thorough study of this subject, he is not qualified to harden and temper modern high speed steel tools, which will perform at their maximum efficiency. A capable heat treater is the first essential. His department should have temperature controlled furnaces and proper drawing baths, all equipped with pyrometers. The pyrometers should be checked at least every 60 days to insure their accuracy. After hardening and drawing, all tools should be checked, preferably on the Rockwell hardness tester, before placing in service. A properly hardened and tempered high speed tool should test from C 62 to C 65 Rockwell. The tool room should be equipped with several types of tool and cutter grinders properly to sharpen the various sizes and shapes of cutting tools. The number of workmen in this department should be sufficient to maintain sharp tools at all times, regardless of how large the general force may be. Unfortunately, quite frequently the proper care of tools is given second place to production. This is basically wrong, as good production can only be obtained with properly maintained cutting and machine tools.

THE READER'S PAGE

Failure of Locomotive Parts

To the Editor:

A section of the report by the Committee on Locomotive Construction at the 1937 meeting of the Mechanical Division was concerned with the failures of axles and crank pins. In the Daily Edition of the Railway Age for June 18, 1937, page 1004D96, you showed the results of a questionnaire covering the period January 1, 1931, to December 31, 1936. Twenty-nine representative railroads out of 38 sent in returns. The distribution of failures by location on the axles and crank pins was as follows:

Axles

13.9 per cent occurred in the wheel fit
86.1 per cent occurred outside of the wheel fit

Crank Pins

30.7 per cent occurred in the wheel fit
69.3 per cent occurred outside the wheel fit

From this it is evident that the greater proportion of these fractures should have been detected while they were still in a progressive state.

It also appears that 90.1 per cent of all axle failures were main driving axles and also that main crank pin failures constituted 78.4 per cent of all crank pin failures. If special efforts could therefore be made to locate progressive fractures on main driving axles and main crank pins occurring outside the axle fit and pin fit, a very large percentage of the failures in service could be prevented.

Does this not suggest a device or method perfected to the point that will preclude errors due to visual inspection and the fallibility of the inspector—a device or method so perfected that each and every one of these progressive fractures occurring outside the fit will be detected before a break occurs? Here is a challenge to designing engineers and scientists.

One railroad has practically eliminated service failures by the simple expedient of applying a service age limit to their main pins and axles. Five years, exclusive of storage, condemns all passenger main axles and all main pins. Since this has been in effect the number of failures on this road has been remarkably low.

Anent F. H. Williams in the *Railway Mechanical Engineer,* the following observations from various persons, all practical, have been made to this observer:

"Tool marks are one of the factors in fractures, where the volume of material is low. As the volume of material increases, the same depth of tool marks as a fracture factor decreases in the same ratio as the volume of material increases."

"Mr. Williams is correct. Sloppy work should not be condoned. Refinements in surface finish at known critical points pay dividends in longevity."

"Unless the finish is sloppy, ordinary tool marks are seldom more than .003 in. deep. A deep tool mark is undoubtedly a factor in a fracture, if it should happen to coincide with the axis of fatigue stress."

"Mr. Williams—the answer to metallurgists' prayers."

"Attributing fractures to tool marks—in some cases such are unquestionably the cause, but the inertia effect when shutting off at high speed or drifting to any considerable extent at speed, is a much more serious phase of the problem."

"One must admire the pioneering urge. All pioneers meet resistance, but there is no denying the fact that pioneers take us out of the rut, stir the imagination and procreate new thought, sometimes in fallow fields."

"Mr. Williams is blazing a new trail. One can parallel a blazed trail and arrive at the same destination."

"Laboratory findings do not always work out as expected in the crucible of operating conditions."

"Elimination of tool marks would remove this controversial bone of contention from the picture. To take the position that any one factor should bear the onus of the fracture is untenable."

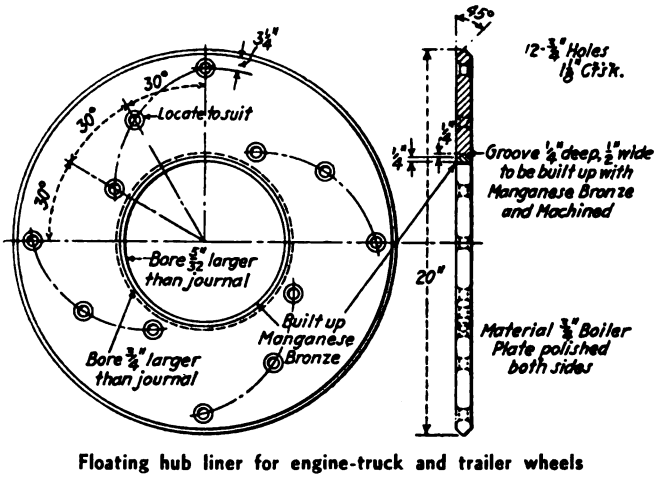
"Constant striving for improvement is often accelerated by pioneers going tangent to accepted practices."

Frank W. Alward.

Floating Liners Eliminate Thermal Checks in Wheel Hubs

To the Editor:

On page 410 of the September, 1937, issue of the *Railway Mechanical Engineer,* General Foreman asks: "What causes thermal checks at the hubs of engine-truck wheels?" Several years ago we had the same trouble with thermal checks resulting from hot engine-truck wheels caused by excessive hub friction. Such trouble resulted in many engine failures and delays, and the maintenance expense of replacing brasses and lateral rings was high.

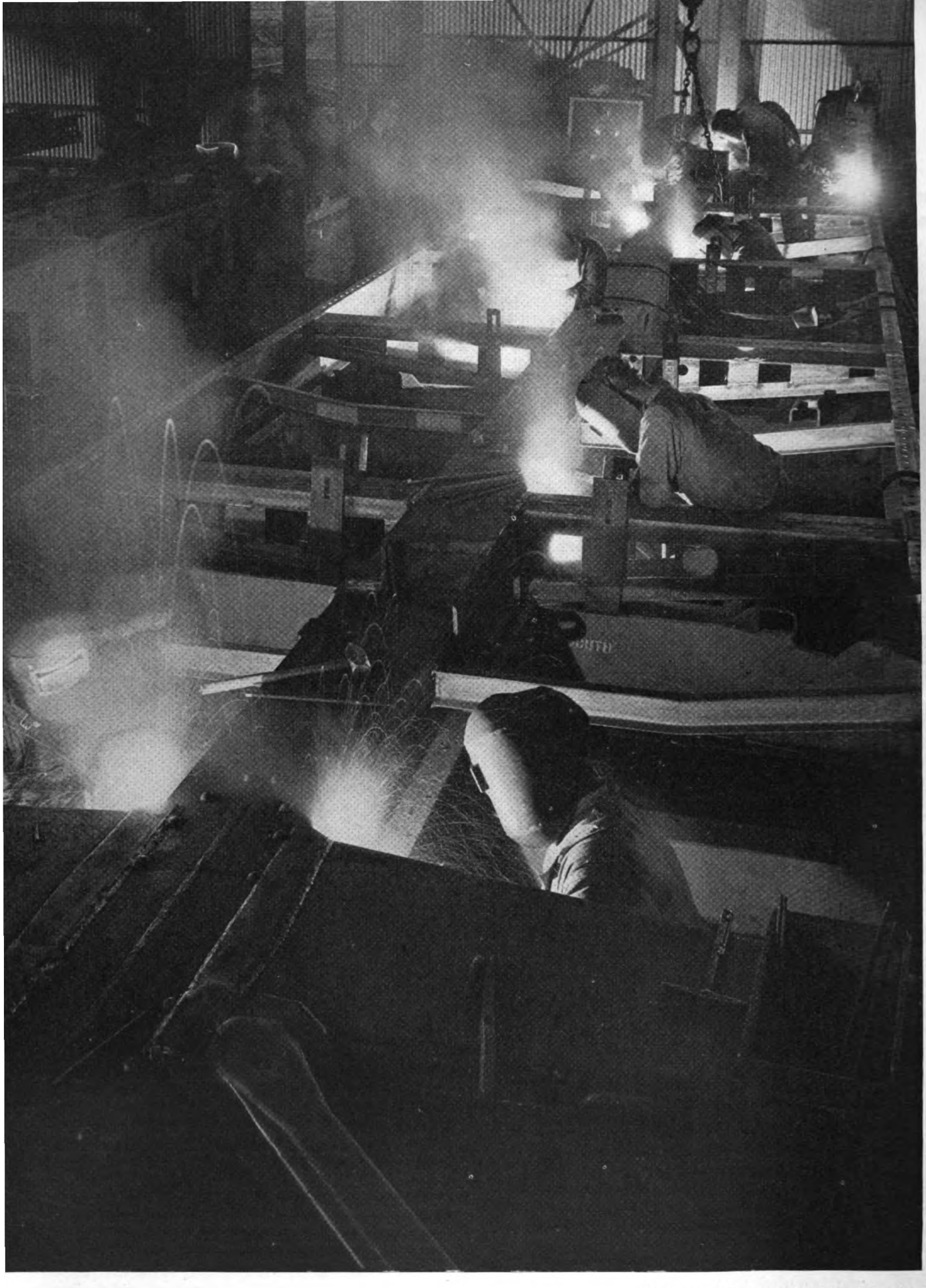


Floating hub liner for engine-truck and trailer wheels

To eliminate such failures we cut down the resistance on the rocker rigging on some of our engines, squared up the frames and jaws, and applied floating lateral rings made from ¾-in. boiler plate as shown in the drawing. We also made an oil cup out of 3½-in. pipe to lubricate the floating rings with engine oil. When we applied a set of floaters we gave the wheels ¼-in. lateral.

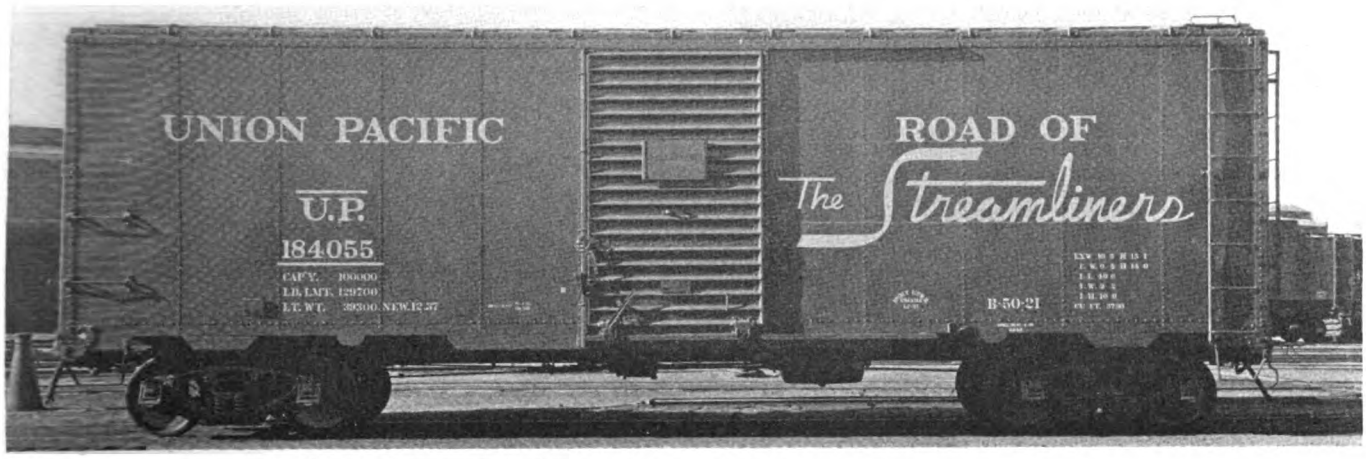
We now have all of our passenger and freight locomotives equipped with such floating liners. This has practically eliminated hot boxes on engine-truck and trailer boxes, but when hot boxes are reported, it is the packing that is the source of the trouble.

Claude J. McCready



Box car underframe in the welding jig which provides for down hand welding exclusively

With the Car Foremen and Inspectors

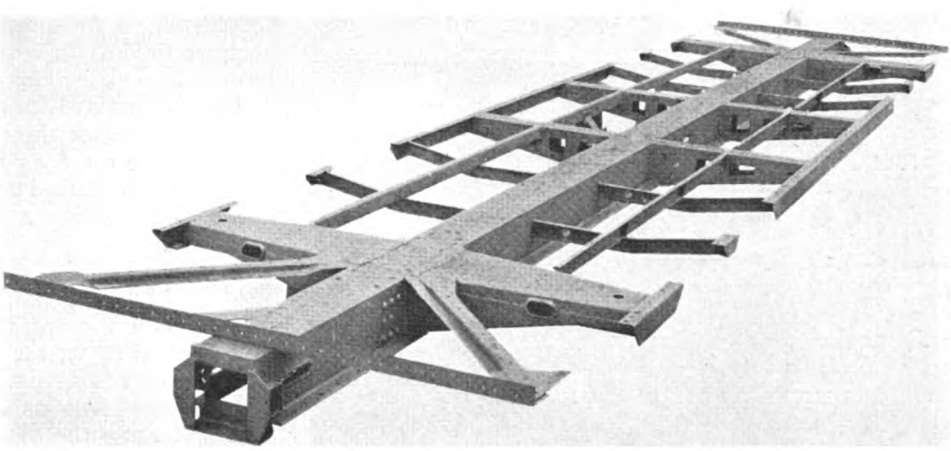


One of the new Union Pacific 50-ton box cars equipped with a welded alloy-steel underframe

New U. P. Cars Have All-Welded Underframes

The Union Pacific is building 1,900 50-ton, lightweight, steel-sheathed box cars, of a modified A. A. R. design with all-welded underframes, in the Omaha, Neb. and Portland, Ore. shops of this road.

The cars are of moderate lightweight construction, weighing 39,300 lb. The car bodies are of alloy steel with the exception of the center sill, safety appliances, and a few heavy-section brake forgings. The trucks are the double-truss spring-plankless type with one-wear wrought-steel wheels and high-tensile cast-steel side frames and bolsters. The bottom connection does not pass through the truck bolster. These trucks weigh approximately 13,400 lb. per car set.



The welded underframe made of high-tensile alloy steel

The underframes are welded throughout, and are being furnished by The Ryan Car Company, Chicago. They are of Cor-Ten steel with the exception of the center sills, which are open-hearth steel, A. A. R. Z-26 section. The strikers are fabricated and welded to the center sill. They are designed to accommodate the Union Metal Products Company's lightweight centering device. The front draft lugs are drop forgings with the key slot reinforcement projecting through the sill and welded to the center sills. The body-bolster center fillers are high-tensile steel castings, heat-treated and riveted to the center sills and body center plates. The body center plates are drop forgings, welded to the center-sill lower flanges.

The body bolsters are pressed pans, welded together to form a box section and welded to the sills. They have a reinforcing splice plate welded across the joint on top. The crossbearers are a box section built up of angles and plates and are welded to the center sill. They have a splice plate on the bottom with center-sill spreader angles attached. The crossties are 4-in. rolled channels with square ends welded to the center sills and side-sill reinforcements. The floor stringers are channel pressings with the bolster and crossbearer attachments pressed on the ends. The brake system brackets are all welded to the underframe.

The underframes are being built, at the Ryan plant, where all welding is done in a down-hand position. This involes the use of revolving jigs on both sub-assemblies and the complete underframe.

The car sides, made of Yoloy and Cor-Ten steel, are furnished by the Youngstown Steel Door Company. The sheets are .067-in. thick. Five hundred car sets have,

16 per car, 3-in. 5.1-lb. open-hearth steel Z-posts and 1,400 cars have 3-in. 4.3-lb. high-tensile Z-posts. The corner posts are 5/32-in. pressed W-sections of high-tensile steel. The side plates are 3/16-in. W-section, 7.8-lb. per foot, copper-bearing open-hearth steel rolled in a Yoder mill. The side-sill angles are 6-in. by 3½-in. by ¼-in. Yoloy steel.

The doors, furnished by the Youngstown Steel Door Company, are equipped with bottom lift fixtures. The door sheets are made of 14-gage (.077 in.) high-tensile steel. The roof is the Murphy solid-steel type, made of 16-gage Cor-Ten (.06-in.) sheets with ⅛-in. low seam caps.

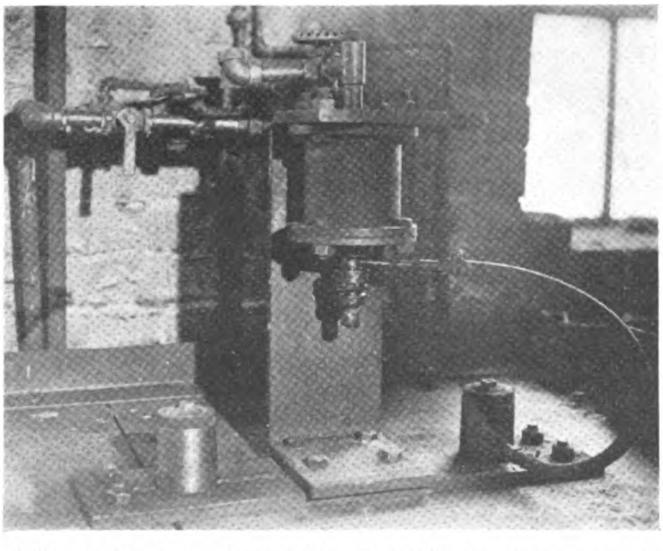
The car body is lined throughout with a ½-in. plywood ceiling, 25/32-in. side and end lining, and 1¾-in. decking. The floor at the door opening on 1,800 cars is bagac and 100 cars are equipped with Chicago Hutchins steel plate. The ends are the Union Metal Products Company's Dread-naught with 5/32-in. top sheets and 3/16-in. bottom sheets, of Man-Ten steel.

These cars, assembled in the railroad's shops at Omaha and Portland, are painted with chromate primer and finished with iron-oxide synthetic freight car paint. Load deflection and impact tests, conducted by the railroad, are said to have proved the satisfactory character of this car design and the construction methods incorporated.

Testing the D-Bodies Of Metallic Joints

By A. Skinner*

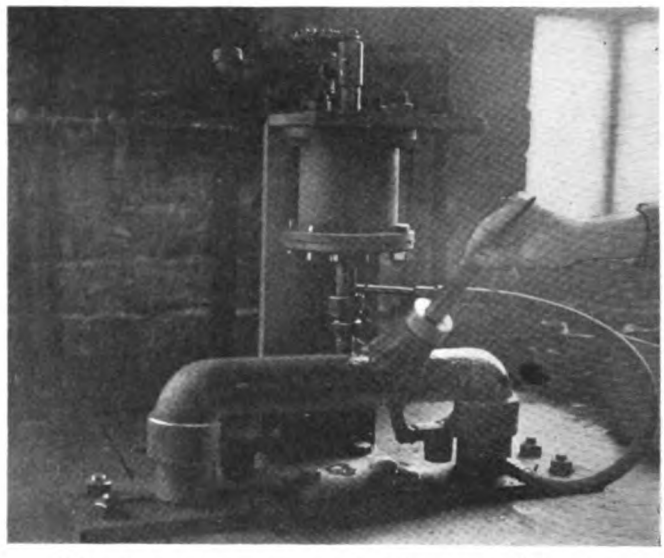
Metallic joints used in steam heat connections between passenger cars are subjected to alternate high steam pressures and condensation which sometimes cause the main D-body sections to rust through or crack, with resultant failures in service. Even when failures do not result, these weakened and defective D-bodies often find their way back into service in repaired metallic joints where



Device used in testing the D-bodies of metallic steam-heat connectors

they again present the hazard of interruptions in steam heat service. To avoid this possibility, the device illustrated provides an effective means of testing all D-bodies before being assembled in overhauled metallic joints and thus assuring that they are in good condition for an extended period of further service. The device is primarily a car department tool used by steam fitters and should be located at or adjacent to the coach yard tracks.

The appearance of the testing device before application of a D-body is shown in Fig. 1. The device consists essentially of two steel D-body supporting posts *R* and *L* mounted on base plate *B*, and bracket F which carries a small air-cylinder *C* designed to hold the D-body against suitable gaskets in the supporting posts while air pressure for testing purposes is applied through a flexible rubber hose connection to one of the posts. The base plate *B* is 5/8 in. by 6 in. by 25 in., being bolted at a convenient place on the work bench adjacent to an



View showing how a soap-suds test is made on this device

air supply line. Each of the steel supporting posts is 2⅝ in. in diameter by 3 in. high, being equipped with ⅜-in. rubber gaskets secured to the upper surfaces by set screws which pass through the rubber and are threaded into the posts. Post *R* is fixed in position, being secured to the bottom plate *B* by ⅜-in. countersunk head stove bolts. This post has an air port drilled horizontally near the bottom and connecting with a vertical port which passes through the center of the gasket and set screw. Post *L* is adjustable horizontally to accommodate slight variations in the length of D-bodies by means of a slot shown in the illustration and a ½-in. T-head bolt.

Bracket *U* is also made of 5/8-in. steel, 6 in. wide by 17¼ in. high, over all, and is fastened securely to base plate *B* and the work bench by means of four bolts through one leg of the *U* as illustrated. The upper leg of the *U* carries a 6-in. by 6-in. cylinder *C* rigidly bolted in an inverted position so that the application of air pressure will cause the piston to move downward and hold the D-body firmly against the rubber gaskets on the supporting posts. While the piston is in this position, air at the same time passes down through a port in the piston rod into the ⅛-in. horizontal nipple and ⅜-in. rubber hose connection to the bottom of supporting post *R*.

Air is supplied to or exhausted from cylinder *C* and supporting block *R* by means of a three-way valve, the handle of which is shown at *V*. The amount of air pressure admitted to the cylinder is controlled by the operator using this 3-way valve and ordinarily does not exceed 45-lb., which is more than enough to indicate any leak when the D-body is given a soap suds test. The

* General foreman, A. T. & S. F., Corwith, Ill.

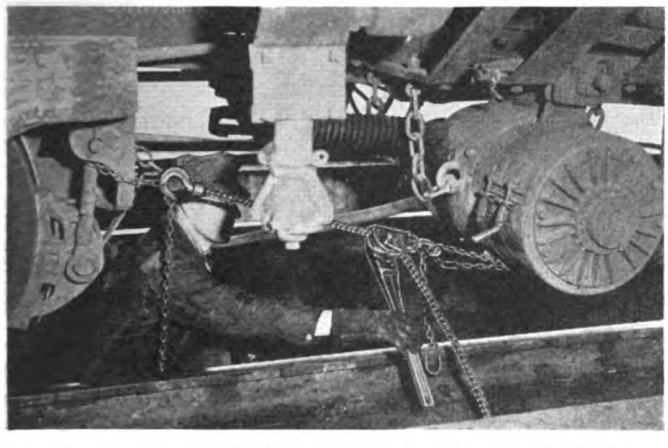
actual operation of making a soap suds test of a D-body using this device is shown in Fig. 2.

Improved Coffing Hoist Reduces Lifting Hazards

The Coffing Hoist Company, Danville, Ill., is now offering to the railroads, and general industry, an improved design of Safety-Pull hoist which is said to reduce or, in fact, practically eliminate hazards in lifting and pulling operations. It is designed on the ratchet-and-pawl principle, which permits using the hoist in a variety of positions, including those with limited head room.

Among the safety features incorporated in this hoist, as now designed, is the push-button control. When the load has been elevated and it is desired to lower the hoist, the operator simply pushes in the button and the hoist's action is reversed. This control also acts as a safety stop; if the worker's hand should slip off the handle while operating, this device automatically and positively locks the handle before it can revolve or cause any damage.

Two other separate safety stops prevent the handle from whirling around and causing injuries to workmen. An intermediate locking pawl works alternately and intermediately with the main locking pawl and enables the



Applying a generator belt with a Coffing Safety-Pull hoist

load to be stopped in locking position at half the length of the regular stroke. This added pawl also serves as an extra safety. In the case of excessive overloads, the handle bends before any other part of the hoist will give. This serves as a warning to prevent the chain from breaking or hooks from straightening out and dropping the loads. The hoists weigh from 14 to 150 lb. and are made for loads from ¾ to 15 tons. Each hoist is factory tested to lift 100 per cent overload.

The uses to which this hoist may be put in railway service are numerous, including all sorts of lifting and pulling jobs in both locomotive and car repair work. It is perhaps most widely used by car men in connection with lightweight steel frames set up over trucks to assist in truck dismantling and assembling operations, as described in the March *Railway Mechanical Engineer,* page 110.

The versatility of this hoist in pulling operations is nowhere better indicated than by its use in applying generator belts, as shown in the illustration. However, where a large amount of this work of applying or adjusting either flat or V-belts has to be done, a somewhat lighter and simpler adaptation of this hoist has been developed. This ratchet-lever puller, with a capacity of two tons and weighing only 12 lb., has a free-chain feature for quick hook adjustment and two feet of Diamond chain of ⅝ in. pitch. A C-clamp hook is used for attaching the hoist to the truck sill on the end of Pullman-type trucks. For other types of drives, special adapters may be furnished and in some cases an ordinary grab-hook chain is used. If two feet of chain is not ample, more chain can be added to suit conditions. Like other Coffing hoists, this one requires little head room; therefore, it is also well adapted for installing and repairing air-conditioning equipment.

How to Stop Sweating of Steel Box Cars—A Suggestion

By R. H. Salter

Steel box cars have a tendency to sweat on the inside when loaded with warm lading during the cold weather, causing considerable annoyance to shippers as well as expense to the carriers. It is the purpose of this article to define the cause of sweating of steel box cars, to point out a few of the results of the condition, to discuss briefly what has been learned by experience with a similar situation and what correctional methods were applied in that situation, and finally to suggest a remedy for sweating of steel box cars.

At the outset we must bear in mind that the sweating of the interior of steel box cars is purely an atmospheric condition, or put in other words, the moisture which is precipitated comes from a certain and given amount of air which is locked inside of a very tight car. In the northern sections of the country, winter weather conditions with temperature at zero degrees or even lower and humidity at close to 100 per cent are common.

Shippers often find it convenient to load their product promptly and even before it has had time to cool. This may be due to brisk sales and limited warehouse facilities. Consequently, manufactured commodities are sometimes loaded at temperatures of 100 deg. F. or even higher. Loading operations require periods of time of varied duration, and during these periods the car doors are open. The presence of the hot lading causes the temperature of the air in the car above the lading to rise to a temperature very close to that of the lading. Naturally, the humidity would fall were it not for the high state of the outside humidity and the open car doors. The humidity inside the car promptly finds its equilibrium with that on the outside.

By the time loading is completed, the air within the car has attained a high temperature as well as a high humidity. The air becomes locked in the car and, as the car walls are made of thin steel plate, they offer little, if any, resistance to heat transfer. A rapid cooling of the lading and the air above the lading takes place. A drop of 10 deg. in temperature causes a rise of 30 per cent in humidity. The only possible result is condensation or sweating on the interior of the steel box cars. As the cooling of the lading continues, the humidity of the air in the car will remain at 100 per cent. This is the dew point, the point of complete saturation, and condensation will continue until the vapor content of the air has been precipitated in the form of water. In very cold weather, the interior of the car becomes coated with frost and even icicles form along the ceiling of the car. In cars moving to warmer regions, the frost and icicles

melt and water damage to the merchandise results.

It is well to bear in mind that the actual dripping of water from the car ceiling is not the only cause of damage to merchandise in sweating cars. Condensation in a given quantity of air sets in when the relative humidity of the air reaches 100 per cent. A humidity of 100 per cent in a car or warehouse is decidedly harmful to many classes of manufactured products stored therein.

The foregoing briefly defines the cause of sweating of the interior of steel box cars and also points out some of the harmful results. The remainder of this article will explain what has been learned by experience in a situation which, in many respects, was parallel to the sweating in steel box cars. About 20 years ago there was developed in Minnesota what is known as the full-view railroad-track scale pit. These pits are 50 ft. long, 10 ft. wide and 8 ft. deep, which dimensions approximate those of the largest box car. The walls and bottom of these pits are constructed of solid concrete 2 ft. thick, while the top of the pit is covered by a platform or deck made of 2-in. planks well matched, tarred and painted. This construction made them very nearly air and water tight.

These pits, containing the iron structural and operating parts of the scales, were believed to be the acme of perfection in track-scale construction. This, however, was soon found not to be so. The very first difficulty encountered was a pronounced condensation and sweating condition. The pits were always wet and clammy, due to the high state of humidity therein, and this caused very rapid deterioration of the iron scale parts. It became so alarming that something had to be done about it.

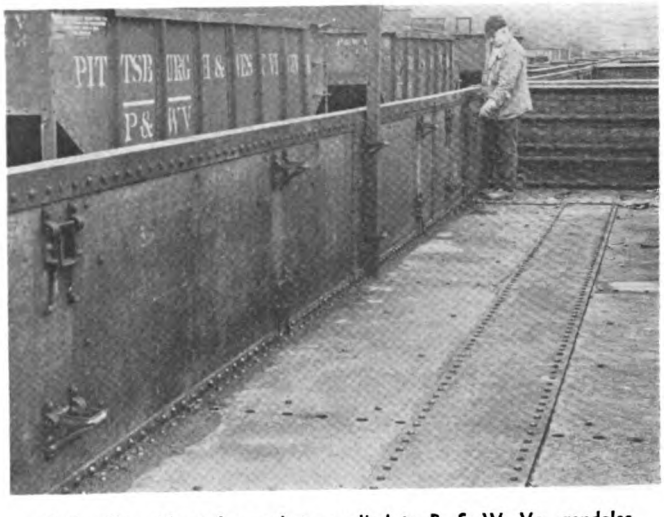
The subject was brought up at a scale-experts' convention for consideration. In a discussion of less than an hour's duration, a plan was adopted and the following described installations recommended: One hole 10-in. square was cut through the scale platform at each end. From this opening a sheet steel spout, open at the lower end and covered at the top by a floor register, was extended downward to within 5 in. of the floor of the pit. On the scale house was erected an 18-in. sheet-steel vent pipe 12 ft. high which tapped the scale pit at the top directly under the platform. This arrangement established a system of gravity ventilation which set up a very gentle current of air through the pit. The system functions satisfactorily at all times regardless of weather conditions, without cost or attention. All scale pits in which this system has been installed are dry.

On the basis of the foregoing experience, would one not think that the only practical way to overcome sweating in steel box cars would be the installation of a properly designed system of gravity ventilation? The installation of such system in a scale pit was comparatively easy. The arrangement of air conductors and vent pipes is not in the way nor is its free action ever obstructed.

The designing of a system for ventilating a box car is more difficult for a number of reasons. The car is a moving object with 100 per cent exposure to the weather. At times it may encounter a wind velocity in excess of 100 m. p. h. While the train is traveling at high speed, a rush of air is set in motion down and around the end of the car. The air may be filled with flying cinders, dust, rain or snow. All this must be kept out of the car. The ventilation system must be so constructed that it will not be in the way of the lading or be obstructed by the lading, it must not add to the cost of the car, and above all things it must work. This is a large assignment, but it can be done. The wonder is that it was not done long ago. For all these years the carriers have been patiently paying out a part of their hard-earned revenues on damage claims caused by the sweating of their own equipment. Damage of this nature to goods while in transit must be paid for by the carriers; it is a cash outlay and an absolute loss. Could this not be saved by proper ventilation of steel box cars?

Malleable-Iron Collapsible Side-Stake Pockets

The accompanying illustration shows a typical installation of a collapsible malleable-iron side-stake pocket used on a gondola freight car. The pocket consists of a main link malleable-iron casting, two malleable-iron brackets or bearings, and one forged-steel knee brace. The main link in this case has an inside dimension of $4\frac{1}{16}$ in., making it suitable for 4-in. by 4-in. posts. It may be made, however, for different sizes of stakes. The side brackets have bearing pockets for the anchor legs of the main link and resting flanges for the knee-brace terminals. Strength and toughness, facility of operation,



Collapsible side-stake pockets applied to P. & W. Va. gondolas

and lightness of section are provided by the design and composition of the pocket, and the side arms of the link frame are ribbed to give the best combination of strength and lightweight section.

The design shown is of the kind installed on 100 Pittsburgh & West Virginia cars during the past year. A variation of this design was employed on another railroad. A double main link was constructed to provide post clearance past the top side plate on the freight cars in question. The weight of the double-link casting is 8.4 lb. as against 3.7 lb. for the single-link type; in each case, the brackets weigh 3.5 lb. per pair and the knee brace forging weighs 2.3 lb.

The view in the gondola shows some of the pockets in active position and some in collapsed state. The assembled pocket opens and closes easily. The knee-brace feature permits easy placing of stakes without resistance or clamping on the part of the pockets. Similar advantages are obtained when removing posts, as the main link is prevented from raising much above the horizontal by the design of the link surface resting against the car side. When posts are moved, the pockets automatically drop into collapsed position.

This side-stake pocket is manufactured by the Fort Pitt Malleable Iron Company, Pittsburgh, Pa., a member of the Malleable Founders' Society.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.A.R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Axle Dimensions — Original Record Altered After Rendition of Bill

On November 9, 1935, the Chicago, Burlington & Quincy applied new wheels to a Seaboard Air Line 80,000 lb. capacity box car, in place of wheels removed because of owner's defects; the axle removed was secondhand. In the original record of repairs, the C. B. & Q. showed that new wheels were mounted on an axle with a center diameter of 5 3/16 in., 1/16 in. below the condemning limit.

The Seaboard Air Line took exception to the application of the scrap axle, after which the C. B. & Q. changed the diameter to read 5 13/16 in., quoting Rule 7, section 4, paragraph 3 as authorization for the change. The S. A. L. declined to accept the correction, contending that the decision of Arbitration Case 1722 prohibits any correction on the repair card after the bill has been rendered; the owner also declined to submit joint evidence to support the claim that a scrap axle was applied with this car. The C. B. & Q. contended that Case 1722 is not parallel, and that the claim for wrong repairs must be supported by joint evident in accordance with requirements of A. A. R. Rule 12. In rendering a decision on Nov. 8, 1937, the Arbitration Committee stated: "According to the agreed statement of facts, the original record of repairs as written at the car shows center diameter of axle applied as 5 3/16 in. There is no authority under the rules to alter this record without actual re-inspection of the axle. Therefore, the contention of the Chicago, Burlington & Quincy is not sustained."—*Case No. 1756, Seaboard Air Line versus Chicago, Burlington & Quincy.*

Questions and Answers On the AB Brake

Brake Cylinders (Continued)

278—*Q.—What must be done before the packing cup is applied?* A.—The felt swab on the piston must be carefully cleaned, relubricated and adjusted to make contact all around the cylinder wall.

279—*Q.—What attention should be given the brake cylinder walls?* A.—They should be thoroughly cleaned, rust spots removed and lubricated with a good grade of graphite air-brake-cylinder grease.

280—*Q.—What attention should be given the release spring?* A.—It must be inspected and cleaned, and any rust or dirt removed.

281—*Q.—What other features in the non-pressure head should be given attention?* A.—The hair strainer and piston-rod seal must be removed and cleaned.

282—*Q.—How can the hair strainer be removed?* A.—It can be removed from the inside of the non-pressure head, being held in place by a wire spring; the strainer parts are released for removal by closing the spring ends.

283—*Q.—What should be done with the piston sleeve?* A.—It should be cleaned and inspected, all rust spots removed, and an examination made of the piston-sleeve seal rings for wear. The piston-sleeve swab should be examined and renewed if necessary.

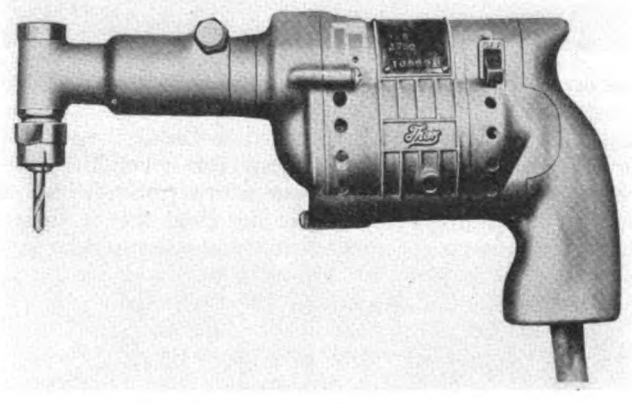
284—*Q.—Before replacing the swab, what should be done?* A.—The swab should be soaked in a good grade of light oil.

285—*Q.—Why is this precaution necessary?* A.—If the swab is not thoroughly soaked, the piston sleeve eventually becomes dry, due to the fact that a dry swab would absorb the lubricant from the piston sleeve.

286—*Q.—When assembling the swab and seal rings in the non-pressure head what precaution must be taken?* A.—After the sleeve is well covered with graphite grease, apply the swab over the piston and into the stuffing box, being sure to ascertain that the contracting spring ring, which holds the swab in contact with the rod, is around the outer diameter of the rod. The swab container is placed over these, and followed by the three brass rings. Additional graphite grease is then applied to the top ring, after which the follower plate is bolted in place.

Right-Angle Drill For Close-Quarter Work

The illustrated Thor right-angle drill with a possible working clearance of only 2 3/8 in. and built in 3/16 in. and 1/4 in. capacities is now being marketed by the Independent Pneumatic Tool Company, Chicago, as the U14R drill. The drill head on this unit measures only 2 1/8 in. overall and the angle attachment can be turned and clamped in any position, making it possible to drill in places formerly inaccessible.



Thor 3/16-in. portable right-angle drill

This addition to the Thor line weighs 3 lb. and has an overall length of 9 1/4 in. Equipped with 1/16-in., 3/32-in., 1/8-in., 5/32-in. and 3/16-in. collets for twist drills, it offers a wide drilling range. It can also be supplied with a spindle to take a 3/16-in. chuck. The spindle offset is 13/32 in. This drill operates at a speed of 2,700 r.p.m., but it can also be furnished with speeds of 3,750 r.p.m. (U14R) and 5,100 r.p.m. (U15R). Construction features include a triple-insulated hand-wound armature, a commutator built on a brass sleeve to eliminate high bars and floating segments, alloy-steel spiral helical gears and a radial-vent cooling system.

Tools Tipped with Non-Ferrous Alloy and High-Speed Steel

At the West Albany shops of the New York Central, turning tools are being fitted with non-ferrous alloy tips and high-speed tool-steel tips by methods, developed at the shops, which have practically eliminated tool replacements due to broken or loose tips. The tool shanks are made of scrap tire metal machined to the desired shape for the various turning operations for which the tools are intended. For example, one of the tools, which is used for machining cylinder packing rings and is shown in the illustrations, is about 6 in. long and machined to take a ½-in. by ¾-in. by 1⅛-in. non-ferrous alloy tip; it is used until but $\frac{1}{16}$ in. of the tip remains, during which 3,000 rings are machined. One of the illustrations shows the tool ready to receive the tip, the tool with the tip applied but not ground, the tool ground ready for use, and the tool after turning 3,000 rings; the latter shows the $\frac{1}{16}$ in. non-ferrous alloy remaining on the tool. The production cost per packing ring per tool is but 0.066 cents, since 3,000 rings are machined per tool which costs $2.00, including labor and material charges.

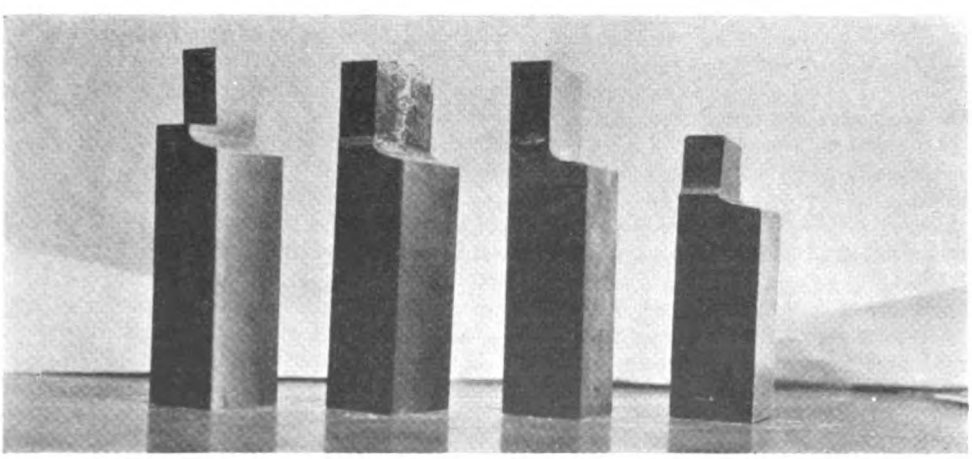


Tools tipped with non-ferrous alloy are heated by an oxyacetylene flame

The fact that the tool can be used until but such a small piece of non-ferrous alloy tip remains is attributed to the method used in applying it. The method of applying the tip is as follows: First, the tip of the shank is dipped in tetrachloride to remove grease spots, after which it is clamped in a vice. The tip is then applied to the shank with a pair of tongs to avoid handling with the fingers which might put an oil spot on the tip. With the tip in place, the shank and sides of the tool are heated with an oxyacetylene torch to a cherry red color, using a non-oxidizing flame; during this heating a good borax is used to clean the seat of the shank and the tip, the borax being applied only to the top of the tip. The welding rod is then touched to the tip after warming the rod so as to prevent cracking the tip which might occur if a cold rod were placed against the tip. The heating is continued until the bronze runs freely on top of the tip, after which it flows beneath the tip by capillary action. When sufficient bronze has flowed under the tip, the tip is pressed into place with the welding rod and immediately placed in lime or some other medium to prevent too rapid cooling which would cause a check or crack in the tip.

The shanks of the tools tipped with high-speed tool steel are also made of scrap tire metal, and the tips are hammered out of scrap butt ends of high-speed tools. The portion of the shank machined to receive the tip is coated with a $\frac{1}{32}$-in. layer of steel-cement flux found especially adapted for the purpose and the tip is set in place, after which the assembly is placed in a pyrometer-controlled furnace and heated to 2,350 deg. F. As soon as this temperature is reached, the assembly is removed from the furnace, the tip is pressed solidly in place, and then cooled to room temperature under an air blast. The tool is reheated to 950 deg. F., after which it is removed from the furnace and allowed to cool naturally to room temperature.

One application of the tools thus tipped with high-speed steel is the turning of engine-truck and car wheels. Normal production with each tip is 25 wheels per grind; with five grindings per tip, the production per tip is 125 wheels. One tool shank can be re-tipped four times, thus making a total production of 500 wheels per tool. Application of the first tip costs 40 cents while the re-

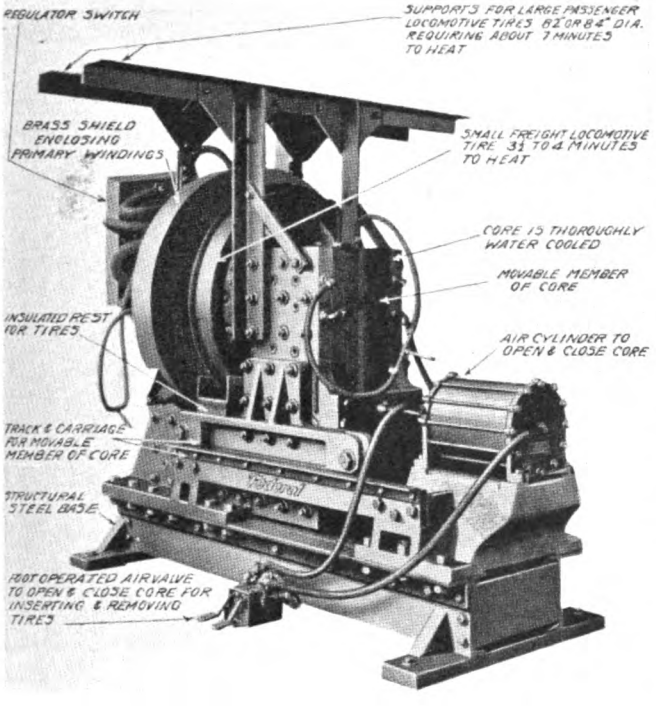


Cylinder-packing parting tool, showing the tool-shank, two views of the tool after the tip has been applied, and the tool after parting 3,000 rings

tipping costs 20 cents each, including labor and material, or a tool cost per tool of $1.00; thus, the tool cost per wheel is but two cents.

Electric Heater for Locomotive Tires

In the accompanying illustration is shown a sliding-core electric tire heater which utilizes the tire itself as a short-circuit single-turn secondary that heats quickly and uniformly when the primary circuit is closed. All sizes of tires can be expanded preparatory to shrinking onto wheel centers. By using a flexible secondary lead, with



Electric tire heater in which the tire acts as a secondary circuit

contact shoes to clamp onto the tires at diametrically opposite points, the tires may be expanded for removal from the driving wheels when they become worn.

The sliding core of this heater is built with a movable end which travels on rollers and track by means of a double-acting air cylinder actuated by a foot valve. This allows the work to be inserted and removed by a crane. The core is water-cooled by means of bronze plates on sides and in the center, with cooling pipes and ducts cast into them. The pressure device is for opening the core and for holding it firmly together when closed.

If the machine is to heat both freight- and passenger-locomotive tires, it should develop 750 kva. If it is to heat freight tires, only 550 kva. is required. The primary coils should be wound for 440 or 550 volts, preferably the latter, and 60-cycle current. It is equipped with air-cooled and tapped primary windings with five steps for varying the current and voltage through a regulator switch, to suit the work. A double-pole, open-type contactor panel of 1,500-amp. capacity for a 550-kva. heater, or a panel of 2,000 amp. capacity for a 750-kva. heater may be used and operated by an auxiliary contactor of 75 amp. and an operating button, or by a double-pole single-throw hand-operated switch.

Freight tires, 36 in. diameter by 3½ in. thick by 9 in. wide are heated to 450 deg. F. in about 4 min. Passenger tires, 82 in. diameter by 3½ in. thick by 9 in. wide are heated in about 7 min. Due to the absorption of heat by the driving wheels, 60 per cent more time is required to heat tires for their removal than to expand them for shrinking on the heater, built by The Federal Machine & Welder Co., Warren, Ohio.

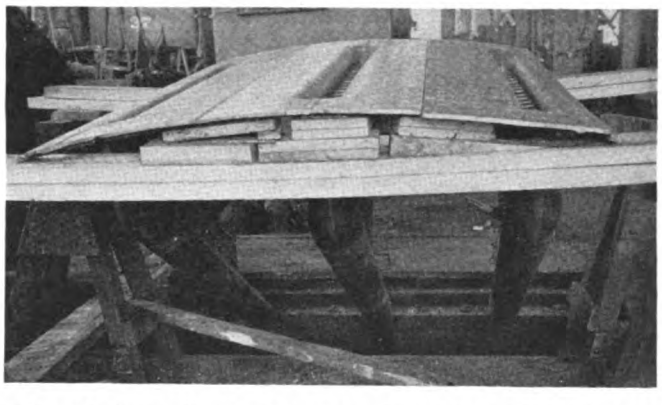
Wide-Flanged Thermic Syphons

The Lehigh & New England recently equipped a locomotive with five wide-flange Thermic syphons, three in the firebox and two in the combustion chamber. The wide flanges of these syphons are butted together, thus forming the entire crown sheet and eliminating two strips of the old crown sheet in the firebox and one strip in the combustion chamber which would be required if narrow-flange syphons were used; their application eliminates two longitudinal welds in the firebox and one in the combustion chamber when compared with the application of narrow-flange syphons.

The combustion chamber of the locomotive being new, the combustion chamber syphons were laid out on the floor, together with the combustion chamber. The combustion chamber was then applied to the locomotive and welded in place.

In the application of the wide-flanged syphons to the firebox, the entire crown sheet was cut out and ¾ in. excess material was left on the side sheets. The center syphon was then set and bolted in position. Marks were made on the door sheet indicating this position, and the center syphon was unbolted and moved to one side. The two outside syphons were then butted to the marks on the inside door sheet which located the center syphon and the side sheets were marked for the butting edges of the outside syphons. The outside syphons were then removed and the side sheets were trimmed.

With the combustion chamber in the locomotive and the side sheets trimmed, the five syphons were bolted in



The wide-flange Thermic syphons trimmed and ready for application

position. The four longitudinal seams in the firebox and the three longitudinal seams in the combustion chamber were tack welded first with the combustion chamber syphons abutting the back flue sheet. All longitudinal welds were then completed, thus permitting the syphons to expand without any danger of buckling. The circumferential welds at the flue sheet, at the juncture of the firebox and combustion chamber, and at the inside door sheet were then completed in turn.



Two weeks after he came on the job, odds were offered that the new master

STRAW-BOSS

by
Walt Wyre

H. H. CARTER, master mechanic of the Plains Division, is rated as one of the best on the S. P. & W. Two weeks after he came on the job, odds were offered that the new master mechanic wouldn't last ninety days. The trouble was Carter couldn't remember he was no longer a foreman. He put in so much time supervising individuals that he had no time left for the job as a whole.

Jim Evans, the roundhouse foreman at Plainville, remembers well when Carter landed there. The new master mechanic paused at the office only long enough to introduce himself to his clerk and look over messages received that day. He spent the rest of the day in the roundhouse.

EVANS was, as usual, short of power the day the new official arrived. The 5088 came in with a bursted siphon that would take a couple of days to repair with all of the other work boilermakers had to do. That wouldn't have been so bad if the 5079 hadn't picked that time to break a main pin.

Evans took a fresh chew of "horseshoe," looked the situation over, and decided he'd better rush the work on the 5082 that was on the drop-pit. One more unserviceable locomotive and the local and limited would have to be run as a mixed train with the switch engine pulling it.



mechanic wouldn't last ninety days

"Wish you fellows would kinda throw your feet out," Evans told the machinists working on the 5082. "Looks like I'm going to need her before you can get her finished."

The nut-splitters agreed and went to work with a will. Machinist Cox was laying out the shoes and wedges when the new master mechanic came through the roundhouse.

Carter watched the machinist a few moments without saying anything. The machinist, naturally nervous under the official's staring gaze, forgot measurements and had to remeasure.

"How do you go about laying out shoes and wedges?" Carter asked.

The machinist hadn't gone far with the explanation when the master mechanic interrupted. "I can show you a much better method."

Carter rapidly and sketchily outlined the method he used. It was probably as good or maybe better if the machinist had understood it thoroughly, but he didn't. Besides, he had to start all over from the beginning.

The master mechanic left the machinist struggling with the unfamiliar method of laying out shoes and wedges and went to the machine shop.

Carter stopped at the shaper where Johnson, one of the machine men, was planing a cross-head gib.

As before, the official watched awhile before saying anything, then he asked, "Is that the fastest speed on that shaper?"

"No," Johnson replied, "but it's as fast as the tool will stand."

"Speed it up," Carter replied. "If you'll grind the tool right, it'll stand more speed."

Johnson is an old head and nobody's fool. He knew the shaper tool wouldn't stand cutting the cast iron any faster, but he also knows better than to argue with a newly promoted official. After they have been on the job long enough to learn that a title doesn't necessarily carry with it a monopoly of knowledge, they are less likely to resent a difference of opinion.

"Would you mind showing me how to grind the tool?" Johnson said very courteously.

"Sure I'll show you," the master mechanic agreed.

The tool was ground with a sharper point and more clearances and put back in the shaper. Johnson shifted the gear lever to the next higher speed and started the machine.

"It'll stand running faster than that," Carter said.

The machinist, without replying, stopped the machine and shifted the lever to the next notch. In less than thirty seconds after the tool bit into metal the point burned off.

"Let's try grinding it again," Carter suggested. "Maybe you gave it a little too much clearance."

When the tool burned up again, the master mechanic admitted that maybe it wouldn't stand the speed. "We'll have to see if we can't get a better grade of tool steel," Carter said as he left.

NEXT day Carter started to leave the machine shop when he noticed a nut-splitter grooving some driving-box brasses. He stopped long enough to offer a little criticism and very emphatically suggest changes in the method of grooving the brass.

In the meantime Evans was having troubles of his own. The inspector found a break in the frame of the 5090. She was otherwise a good engine and the foreman, not knowing of the broken frame, had planned to work her and run her east on first 82 about six o'clock that evening.

Evans went in search of Henry Barton. Barton is the best welder in Plainville and a lot of other places, too. He is the only one there that can put a patch on a siphon in a reasonable length of time.

The foreman went to the 5088 and climbed up in the cab. He looked into the fire-box where he expected to find Barton working on the bursted siphon. Barton wasn't there. Instead, a helper was gathering up the tools.

"Where's Barton?" Evans asked.

"Went to look for you," the helper replied. "He's sick and wants to go home."

"I'm sick too," Evans said, "but I can't go home. Was he very sick?"

"Feeling pretty bad, at least, he looked like he did."

Evans swore mildly and climbed down from the cab. He had been figuring on having Barton work overtime welding the broken frame. Jenkins, the machinist welder, is just fair, and Evans didn't much like the idea of putting him on the frame. Besides he would take at least half again as long to get the job done as Barton would.

The foreman walked through the house figuring as he went on how to make eight trains go into seven locomotives without any trains left over. It was a problem that would have puzzled Einstein.

At stall number twelve Evans saw Carter. The master mechanic was instructing a machinist on how to pull a piston when Evans came up. The foreman and master mechanic were not strangers to each other. They had

worked together at another enginehouse several years before.

They exchanged greetings and shook hands. "How's everything going?" Carter asked.

"Oh, about right, I guess," Evans replied. "I've got eight engines to run, only seven in sight, and none O.K. Guess I'd better go to the office and check up on what's coming in."

Much to the relief of the machinist who was pulling the piston, the master mechanic went too.

"Dispatcher wants to know what's lined up for 82," the roundhouse clerk asked when Evans entered the office.

"Wish I knew," Evans replied dryly.

"Say, Jim, that 2735 I just came in on—the bell ringer don't work," an engineer stuck his head in the office and announced.

"Is the east local in already?" Evans asked.

"Yeah," the engineer replied, "I just came in on her."

"How is the 2735?"

"Good engine," the hoghead replied, "except the bell ringer don't work."

"Booster in good shape?" the foreman asked.

"Yeah, working good."

"Tell the dispatcher we'll use the 2735 on 82," Evans said to the clerk.

"But he wants a 5000," the clerk reminded.

"A 2700 with a booster will get the job done," Evans said. "Besides, it's all I've got."

NEXT morning the new master mechanic was on the job bright and early. He was in the roundhouse before eight o'clock and except for brief periods at the office and a short thirty minutes for lunch spent the day in the roundhouse. He managed in the course of the day to ask every man on the job what he was doing and why. Some he asked two and three times and in most cases found fault with what they were doing or the manner in which it was being done. Carter spent nearly thirty minutes with the tank washer showing him how to do a better job washing engine tanks.

About ten-thirty machinist Horton was getting ready to put in a new main pin to replace the one that broke on the 5079. The engine had come in the night before and Evans was in a rush to get it ready to run. The old pin had been burned out. The machinist with his helper had the wheel jacked up and was getting ready to heat the tire to take it off when the master mechanic came up.

"What you going to do?" Carter inquired.

"Take off the tire," the nut-splitter explained. "We're going to put in a new main pin."

"You're wasting time taking off the tire," the master mechanic said.

"We've always took the tire off when we put in a main pin," Horton replied.

"Yeah, there's been a lot of things done around here that's going to be changed," Carter said. "Go ahead and put your pin in."

The machinist and his helper hung a heavy ram to drive the pin. A machine hand had already calipered the hole and was turning the pin.

Horton's helper rigged up a big kerosene torch to heat the wheel. The machine hand had the pin finished before the wheel was hot. He brought the pin in and laid it down on a nearby tool box.

"It ought to be hot enough by now," the master mechanic said a few minutes later.

"Get a couple of men to help handle the ram," the machinist told his helper.

Horton and his helper shoved the pin in the hole. It went about one-fourth of the way and was too tight to go by hand.

"Ram it," the machinist said, with added superlatives.

"You can drive it with a sledge," the master mechanic suggested.

The helper let go of the ram and went to the tool box for a heavy sledge. The helper started to hit. The ram was in the way. He waited until it was swung around parallel with the engine.

The pin moved about one inch and stuck. The few seconds lost getting the ram going allowed the pin to get warmer and stick more solidly. And stuck solidly it was. Even the heavy ram wouldn't move it.

Carter exploded like a bunch of torpedoes thrown in a fire-box. "The master mechanic pitched a hissy," was the way Horton expressed it later when telling about it in the washroom.

Evans came up about the time the master mechanic was having the brain storm. One glance was enough to let the foreman know what had happened. Evans turned on his heel and headed back in the direction from which he had come. His nickel's worth wasn't needed there.

Evans went to the drop-pit to see how things were going on the 5082. He found that the wheels were up but it seemed that something had gone amiss. Cox was standing beside the locomotive looking at it, a puzzled expression on his face. The machinist helper was helping to look, but was letting the machinist do the puzzling unassisted.

"What's the trouble?" Evans asked.

"She's away off," the nut-splitter replied. "I slipped somewhere laying out the shoes and wedges, but blamed if I know where!"

"You've laid out enough shoes and wedges to get them right," Evans said with some irritation in his voice.

"Yes, but I was using a new method, one the master mechanic showed me," Cox said. "Guess I didn't get it exactly."

Evans opened his mouth to say something, but took a chew of "horseshoe" instead and turned and walked off.

Barton was still off sick. Evans had hoped the welder would be back to finish the siphon patch and weld the broken frame. He could wait no longer, though. Four locomotives out of service was at least two too many. The foreman found the machinist welder and told him to weld the broken frame. "Stay with it until you get it finished," he told the welder.

Evans told a boilermaker to start on the siphon patch, then went to the office to see if he had any aspirin tablets.

There was two hours and forty minutes delay on 82 that evening waiting for an engine. He had to work the one that came in on the fast freight and run it through.

THREE days after Carter came to Plainville, the superintendent of motive power visited the place to see how things were going. The s.m.p. found the master mechanic supervising the construction of a walk. Not only was he supervising the construction, he was helping.

That morning Carter saw a laborer pushing a two-wheeled truck hauling a side rod to the blacksmith shop. The truck wheels sank in the dirt and it was tough going.

"Why haven't you got a walk from the roundhouse to the blacksmith shop?" Carter asked.

"I don't know," the laborer replied. "Just never have built one, I guess."

"Isn't there any old fire-brick around here?"

"Yes, sir; there's a lot of them loaded in a car to be hauled off," the laborer said.

"Well, get another man to help and start bringing them. We'll build a walk. No, take the side rod in the blacksmith shop first." The laborer had started to dump the rod on the ground and go after brick.

Carter lined up the walk and showed the laborers how

he wanted the brick laid. Three laborers were working on the job, two hauling bricks and one digging out a place to lay them. The laborer didn't get the brick laid evenly enough to suit the master mechanic, so he started laying them himself.

That's what he was doing when the superintendent of motive power found him. Carter was on his knees in the dirt. The three laborers were at the moment watching the official and listening with well simulated interest while he explained the fine art of making a walk of discarded fire-brick.

"Well, what have we got, a new straw-boss on the labor gang?" the superintendent of motive power asked.

Carter hadn't seen the superintendent of motive power come up. In fact, he didn't know he was anywhere near until he spoke. He rose from his knees. Carter's face was the color of a new red flag when he rose and faced the superintendent of motive power.

The master mechanic spent the next few days going over the division with the s.m.p. The laborers working on the walk gleefully broadcast what the s.m.p. had said. The nickname "straw-boss" stuck for many years. It's occasionally used even yet.

Carter should have learned his lesson at once, but he didn't. But remember, he had been a foreman for years and a master mechanic only a few days. When he returned from the trip over the division, he spent somewhat less time in the roundhouse than before, but he wasn't weaned, not by a lot.

The record on the Plains Division the first month Carter was there was nothing to brag about. Seven engine failures and more delays than he liked to think about is nothing to be proud of.

The second month was very little better and in some ways was worse. Overtime worked was excessive and the overrun of the monthly allowance caused such a howl from the head office that clerks thought the vice president in charge of operation had his tail caught in a crack.

As things got worse, Carter worked harder. As Carter worked harder, things got worse. The master mechanic tried personally to oversee every job that was done on the Plains Division, particularly at Plainville where most of the work is done. The official came down nights and stayed in the roundhouse hours at the time.

Foremen would tell the men to do a job in a certain way. The master mechanic would come along and tell them to do it differently without saying anything to the foreman. The men didn't know what to do. They became disgruntled and did less work than before.

Carter was trying, trying hard to do a good job. He drove himself mercilessly, sixteen and eighteen hours a day on the job, but conditions got worse. The master mechanic couldn't figure out where the trouble lay. He began to think that every one was working against him, that even the foremen were, to say the least, not trying to help him.

If the master mechanic didn't know what the trouble was, most every one else in the shops did. The men knew and discussed it freely among themselves. Machinist Johnson summed the situation up "when it gets like that, it's hell, and it's like that now."

Higher officials looked at records of performance at Plainville and shook their heads. "I thought Carter would make a good master mechanic," the general superintendent of motive power said one day, "but I guess I was mistaken."

THE human machine, like a locomotive, will stand only so much driving, then it's ready to go to the back-shop or scrap dock, depending on condition. Carter drove himself beyond endurance the first three months in Plainville. His eyes were usually red from loss of sleep. His voice became high-pitched and irritating. Every one that could, Evans included, dodged the "straw-boss" whenever they could.

Carter got to feeling so badly that he finally went to see a physician. "Nothing constitutionally wrong, just run down," the physician said.

"Then I'll be O.K. in a few days?" Carter asked.

"No, not a few days; a few weeks, providing you go to some place where you can rest and relax. Get your mind off the job while you still have a mind."

"Where should I go?"

"Go to Hot Springs for six weeks or two months," the doctor suggested.

"Man, I can't get away for two weeks, let alone six weeks or two months!" Carter objected.

"Well, that's up to you. You asked my advice; I've given it."

"And if I don't?"

"Complete nervous breakdown, months or even years to recover, maybe never. Why man, you're half dead on your feet right now and too hard-headed to admit it," the doctor exploded.

Carter went to Hot Springs. When he reached the sanitorium, physicians made him go to bed. It was two months before he returned to Plainville and the job.

That's what woke Carter up. The second month the master mechanic was gone, the division went without a single engine failure, the first time in years for such a record.

Two months in a sanitorium helped more ways than one. Carter went there a straw-boss with a title. He came back an official. There is some talk now of him being the next superintendent of motive power when Daniels retires next year.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

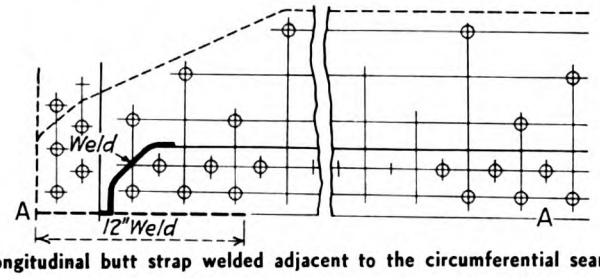
Why Weld the Ends of Longitudinal Butt Straps?

Q.—What is the purpose of welding around the ends of the outside straps of longitudinal seams?—A. L. P.

A.—The welding referred to is illustrated in the accompanying drawing and is used to secure a tight seam and eliminate the necessity of caulking the outside welt strap adjacent to the circumferential seam of the next course.

The 12-in. of welding along the front of the shell course, under the outside welt strap is used to insure a tight seam. The joint of the shell course to which the seam is attached is along the line *A-A*. Due to the fact that the edges of the inside welt strap are not caulked, the tightness of the seam is dependent upon the caulking of the outside welt strap. The caulking and welding of

the outside welt strap causes the seam to be tight at all points except the short space between the end of the butt strap and the shell plate of the adjacent course and for this reason same must be welded to insure a tight



Longitudinal butt strap welded adjacent to the circumferential seam

seam at this point. The weld is usually made about 12 in. long. Before welding was used at this point the seams were made tight by applying a 7/8-in. diameter screwed plug.

Why Is a Pyrometer Used on a Locomotive?

Q.—What is the purpose of a pyrometer on a locomotive and how does it work?—M. K.

A.—For the successful and economical operation of the locomotive, maximum superheat is just as essential as full boiler pressure. It is, therefore, necessary that some reliable means be provided to indicate to the engineman the temperature of the steam going to the cylinders. By indicating these temperatures, the superheated-steam pyrometer enables the engineman to check the performance of the locomotive and makes possible the highest standards of operation.

Locomotive superheaters are designed to develop steam temperatures of 600 to 750 deg. F. Any reduction of these temperatures, when the locomotive is working, indicates to the engineman that something is interfering with the proper performance of the superheater which can and should be corrected.

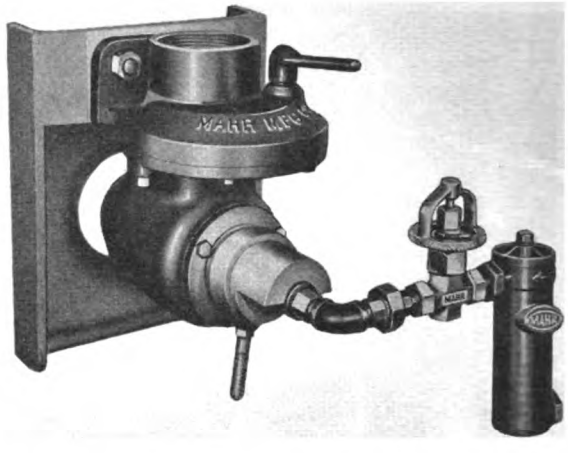
Plugged flues will restrict the flow of hot gases. Carrying water too high means that it must be evaporated in the superheater; a purpose for which it is not intended. Careless or indifferent firing, flue leaks, front-end air leaks, as well as improper draft adjustments, influence the superheat. The effect of any or all of these conditions is shown immediately on the dial of the superheated-steam pyrometer. The pyrometer conveys this information to the engineman in exactly the same manner as the steam gage registers the steaming qualities of the boiler; the principal difference being that the pyrometer indicates the defects before they have become serious enough to affect the steaming of the locomotive and register on the steam gage.

To indicate properly these variations in superheat, the pyrometer must be dependable, accurate, rugged, and sensitive, respond quickly to any change in temperature, and possess the same relative characteristics as the steam gage. The pyrometer is based on the thermocouple principle, by means of which an electric current is generated proportional to the difference in temperature between the hot and cold junctures of the thermocouple. The indicator itself consists of a millivoltometer actuated by the current generated at the thermocouple and moves a pointer on a calibrated dial, indicating the actual temperature of the steam.

The pyrometer equipment for each locomotive consists of three parts: the steam fixture, the indicator and the cable connecting the steam fixture to the indicator. The cables are furnished in five lengths (30 ft., 39 ft., 60 ft., or 75 ft.) to suit the size and type of the engine. The indicator is located in the cab at a convenient point on the back-head of the engine, and is furnished with either Fahrenheit or Centigrade scale as desired. The steam fixture contains the end of the thermocouple which is exposed to the flow of the superheated steam on its way to the cylinders. The slightest variation in the steam temperature immediately affects the previous voltage set up by the thermocouple and indicates this change on the dial in the cab. The cold junction of the thermocouple is at atmospheric temperatures, the variations of which are automatically compensated for.

Low-Pressure Oil Burners

The Mahr Manufacturing Company division of Diamond Iron Works, Inc., Minneapolis, Minn., recently announced a complete line of low-pressure triple-atomizing oil burners known as the 20 series. These burners, embodying a number of features which contribute to flexible and efficient operation when using all grades of fuel oil, are designed for use in industrial-heating operations.

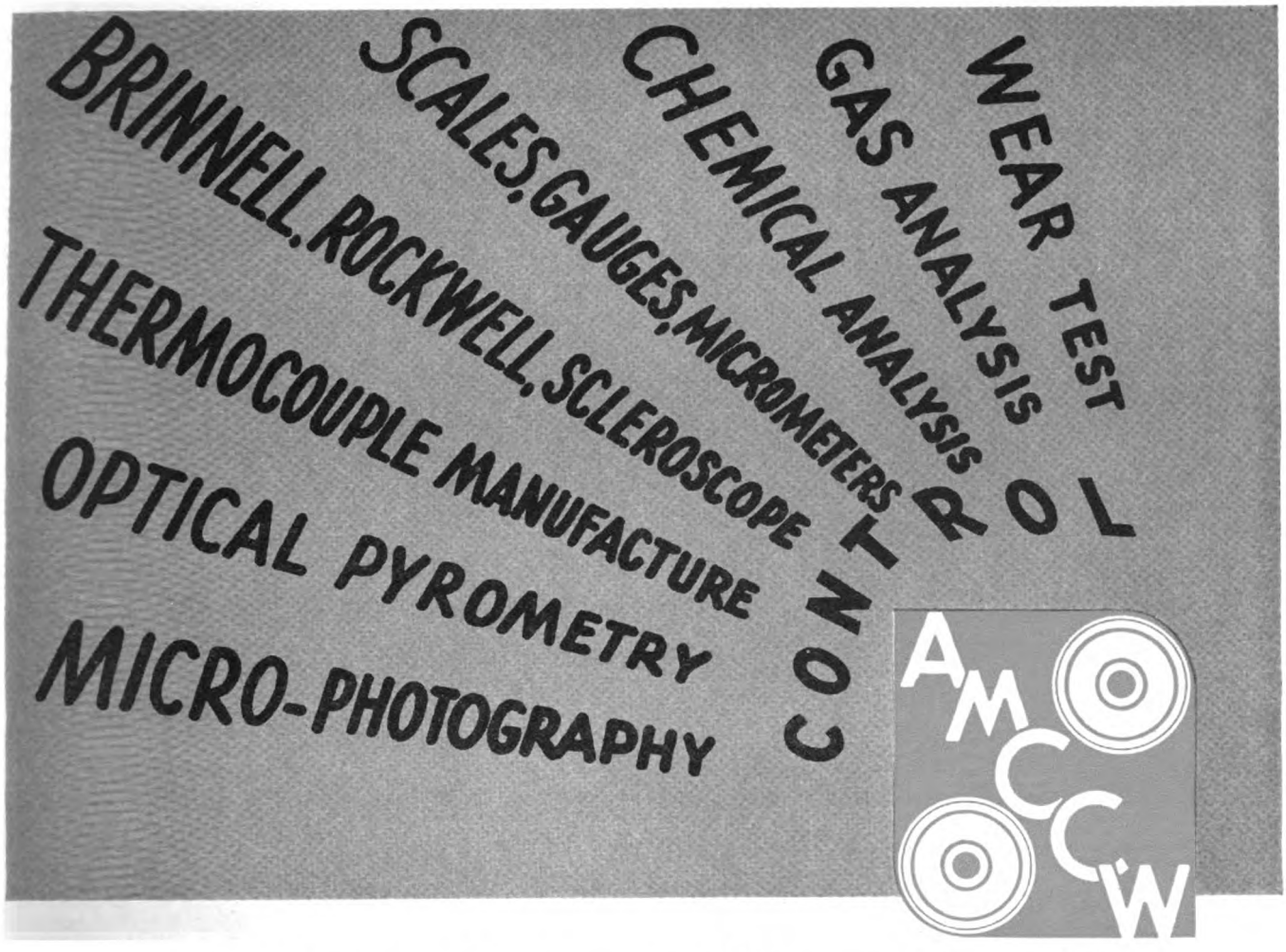


One of the Mahr low-pressure series 20 oil burners—these burners can be used for low-pressure gas by interchanging the internal unit

All parts are accurately machined to insure uniform operation of all burners of the same size and to insure ease of parts replacement. By the removal of three cap screws and the oil connection, the entire atomizing unit may be removed for cleaning when necessary. The design of the blast gate and burner mounting is such that the entire body may be removed for repairs to the heat duct without disturbing the air line.

It is reported that the burners are extremely easy to light even with the heavier grades of oil and a cold furnace. They are free from oil drip and carbonizing in the heat duct. The air is controlled by a lever handle on the internal unit. Turning the handle to the right closes the air, the same as on any valve. The oil supply is controlled by the Mahr type G oil-regulating valve. Each burner is also equipped with one large fine-mesh oil strainer.

These same oil burners may also be used for burning high-pressure gas by installing the gas line in place of the oil line. For burning low-pressure gas, a special gas internal unit is installed in place of the oil internal unit. All parts are interchangeable and can be changed from one fuel to the other in a few minutes.



Maintaining Standards for the Industry

New standards of plant performance for chilled wheel manufacture have required closer control of key operations. The development of better instrumental control has been an important feature of our research program. Notable among the accomplishments of this department are—

1. **The calibration, repair and standardization of pyrometric equipment for the industry.**
2. **The manufacture of thermo-couples for the industry, especially designed for our operating requirements.**
3. **Manufacture of gages and other test equipment for our Inspection Department.**

The improved foundry control, possible by means of these standard instruments, has materially aided in maintaining that degree of improved quality and uniformity which chilled car wheels now possess.

H. G. Hardis
PRESIDENT

ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS

445 N. Sacramento Blvd., Chicago, Illinois 230 Park Avenue, New York, N. Y.

Among the Clubs and Associations

Master Boiler Makers' Association

Obviously, under present conditions, it will be impossible to hold large conventions of railway associations this year. Realizing this, the Master Boiler Makers' Association, as in the years 1935 and 1936, anticipates holding what might be termed a business meeting at the Hotel Sherman, Chicago, next September. If, however, conditions at that time are such that even a meeting of this type is not advisable, then the committee reports and special papers will be released in the form of printed proceedings and will be sent to the members. The following committees have been appointed to prepare such reports:

Topic No. 1—What means can or have been suggested to improve circulatory and other conditions in the locomotive boiler to eliminate leaky stays and cracked side sheets:

C. W. Buffington (chairman), general master boiler maker, Chesapeake & Ohio, Huntington, W. Va.
John F. Powers (vice-chairman), system boiler inspector, Chicago & North Western, Chicago.
John A. Doarnberger, general master boiler maker, Norfolk & Western, Roanoke, Va.
Walter R. Hedeman, assistant to chief of motive power and equipment, Baltimore & Ohio, Baltimore, Md.
D. A. Stark, general boiler and machinery inspector, Lehigh Valley, Sayre, Pa.
H. E. May, shop engineer, Illinois Central, Chicago.

Topic No. 2—Honeycombing and slagging of flues and tubes. Its cure and prevention:

Myron C. France (chairman), general boiler foreman, C. St. P. M. & O., St. Paul, Minn.
B. C. King (vice-chairman), general boiler inspector, Northern Pacific, St. Paul, Minn.
E. E. Owens, general boiler inspector, Union Pacific, Omaha, Neb.
Albert W. Novak, general boiler inspector, C. M. St. P. & P., Minneapolis, Minn.
Julius A. Kahn, general boiler foreman, Elgin, Joliet & Eastern, Joliet, Ill.

Topic No. 3—Which type of application of waist bearer angles or tees give the least trouble?

Edward H. Heidel (chairman), general boiler department foreman, C. M. St. P. & P., Milwaukee, Wis.
Louis R. Haase (vice-chairman), district boiler inspector, Baltimore & Ohio, Baltimore, Md.
H. H. Service, general boiler inspector, A. T. & S. F., Topeka, Kan.
W. M. Wilson, assistant general boiler inspector, C. R. I. & P., Kansas City, Mo.
William Freischlag, general boiler foreman, Wabash, Decatur, Ill.

Topic No. 4—Pitting and corrosion of locomotive boilers and tenders:

J. F. Becker (chairman), general boiler and machinery inspector, Chicago Great Western, Oelwein, Iowa.
J. M. Stoner (vice-chairman), supervisor of boilers, New York Central, Cleveland, Ohio.
W. B. Graham, chief mechanical inspector, International-Great Northern, Palestine, Tex.
Robert D. Merk, district boiler inspector, Great Northern, Spokane, Wash.
R. M. Cincoski, boiler department foreman, Northern Pacific, Livingston, Mont.

Topic No. 5—Prevention of cinder cutting of flues and tubes, firebox sheets, steam pipes, etc.

Sigurd Christopherson (chairman), supervisor of boiler inspection and maintenance, N. Y., N. H. & H., East Milton, Mass.
S. P. Mahanes (vice-chairman), district boiler inspector, Chesapeake & Ohio, Clifton Forge, Va.
H. M. Cooper, district boiler inspector, Baltimore & Ohio, Cincinnati, Ohio.
H. A. Bell, general boiler inspector, C. B. & Q., Lincoln, Neb.
O. H. Kobernik, general boiler foreman, N. Y. C. & St. L., Conneaut, Ohio.

Topic No. 6—What can be done to overcome the cracking of outside throat sheets?

M. V. Milton (chairman), chief boiler inspector, Canadian National, Toronto, Ont.
E. H. Gilley (vice-chairman), general boiler foreman, Grand Trunk Western, Battle Creek, Mich.
E. C. Umlauf, supervisor of boilers, Erie, Susquehanna, Pa.
R. A. Culbertson, district boiler inspector, Chesapeake & Ohio, Huntington, W. Va.
C. H. Pollock, foreman, boiler department, American Locomotive Company, Schenectady, N. Y.

Topic No. 7—In the application of flexible staybolts to boilers, which method gives the best results? (a) Screw the bolt up to a decided seat in the sleeve, cut to length and head over the bolt on the fixebox end. (b) Screw the bolt up to a decided seat in the sleeve and then turn back one-quarter turn before cutting to length and heading bolt over on the firebox end.

Leonard C. Ruber (chairman), superintendent of boiler department, Baldwin Locomotive Works, Darby, Pa.
A. D. O'Neill (vice-chairman), chief boiler inspector, Pere Marquette, Grand Rapids, Mich.
H. V. Stevens, assistant general boiler inspector, A. T. & S. F., Topeka, Kan.
Edward J. Brennan, general boiler department foreman, Boston & Maine, West Medford, Mass.
Frank A. Longo, welding and boiler supervisor, Southern Pacific, Los Angeles, Cal.
Frank Yochem, general boiler inspector, Missouri Pacific, St. Louis, Mo.
W. C. Masters, engineer, Flannery Bolt Company, Bridgeville, Pa.

Topic No. 8—Topics for 1938 meeting.

Carl A. Harper (chairman), general boiler inspector, C. C. C. & St. L., Indianapolis, Ind.
W. H. Kieler (vice-chairman), locomotive inspector, Bureau of Locomotive Inspection, I. C. C., St. Paul, Minn.
T. H. Moore, general boiler inspector, Western Maryland, Hagerstown, Md.
Anthony P. Lieder, general boiler inspector, Michigan Central, Jackson, Mich.
J. A. LaBlanc, boiler department foreman, Canadian National, Quebec, Que.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—R. P. Ives, Westinghouse Air Brake Company, 350 Fifth avenue, New York.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—C. E. Davies, 29 West Thirty-ninth street, New York.
RAILROAD DIVISION.—Marion B. Richardson, P. O. Box 205, Livingston, N. J.

ASSOCIATION OF AMERICAN RAILROADS.—J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.
MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago.
COMMITTEE ON RESEARCH.—William J. Cantley, mechanical engineer Lehigh Valley, Bethlehem, Pa.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, Statler Hotel, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p. m.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings second Friday of each month, except May, June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—F. T. James (President), general foreman, D. L. & W., Kingsland, N. J.

INTERNATIONAL RAILWAY MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

MASTER BOILER MAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September, at Hotel Touraine, Boston.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July, August and September, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, University and Prior avenue, St. Paul.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Calif., alternately—June in Los Angeles and October in Sacramento.

RAILWAY CLUB OF GREENVILLE.—J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, 1255 Old Colony building, Chicago.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

WESTERN RAILWAY CLUB.—C. L. Emerson, executive secretary, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, Aug. and Sept.

(*Turn to next left-hand page*)

EARNING POWER



The increased earning ability of modern motive power justifies the replacement of many thousands of existing locomotives.

● Let earning power be the consideration that governs your choice between repairing old power or buying new locomotives. ● Do not perpetuate old locomotives that will be a drain on increasing revenues.

LIMA LOCOMOTIVE WORKS INCORPORATED

LIMA LOCOMOTIVE WORKS, INCORPORATED, LIMA, OHIO



A Group of New Santa Fe Lightweight Trains at the Chicago Terminal

NEWS

Improvement Programs

The Southern Railway System is renovating and air conditioning certain passenger coaches at an authorized cost of approximately $1,033,000. The program is expected to be completed late this spring.

Chicago, Milwaukee, St. Paul & Pacific.—A budget of $6,058,870 for the Milwaukee has been approved by the federal district court at Chicago. Of the total, about $3,000,000 is for new equipment to be financed out of railroad funds.

Power Reverse Gear Order Is Modified

THE Interstate Commerce Commission has modified its order in the power reverse gear case so that carriers may be permitted to install power reverse gears when class 1 or 2 repairs are made. The original order required the installation to be made when class 3 or heavier repairs were made.

Car Inspector Covered by Federal Safety Appliance Act

A CAR inspector who is injured while inspecting at an interchange point a foreign car not yet accepted by the road employing him may claim benefits under the Federal Safety Appliance Act, such damages to be paid by the delivering carrier, according to a recent decision of the United States Supreme Court reversing a previous judgment of the Supreme Court of the State of Missouri in Brady v. Terminal Railroad Association of St. Louis, 1025 W. (2) 903. According to the testimony rendered in the case, the Terminal Railroad Association had placed a string of cars on an interchange track of the Wabash at Granite City, Ill., where they awaited acceptance by the latter. When Brady, a Wabash car inspector, followed his usual routine of inspecting the cars, prior to acceptance by the Wabash, he chanced to secure himself by a grab-iron which had become loose, due to a rotten board; he fell and was injured.

The plaintiff first sued the Wabash under the Federal Safety Appliance Act, but a judgment in his favor was reversed on the ground that the car had not yet been accepted by the Wabash. While that suit was pending, Brady brought a new suit against the Terminal Railroad Association in the state court.

In its decision in this case, which it accepted on appeal from an adverse judgment by the state court, the United States Supreme Court held that when Brady was injured the defective car was still in use by the defendant carrier, since it had not yet been accepted by the Wabash, and that the statutory obligation of the terminal road continued. During the trial, it was questioned also whether the fact that Brady was not an employee of the Terminal Railroad Association did not absolve the road from duty to him. To this the high court replied that the car inspector was not beyond the statute of the act unless he was outside its scope because of the special character of his work. Since it was of the

(*Continued on next left-hand page*)

New Equipment Orders and Inquiries Announced Since the Closing of the March Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
Canadian Pacific	15	4-6-2	Canadian Loco. Co.
	10	Hudson	Montreal Loco. Wks.

LOCOMOTIVE INQUIRIES

Chicago & North Western	1–6	15,000-gal. tenders	

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Bangor & Aroostook	500	40-ton box	Magor Car Corp.
	115	70-ton hopper	Bethlehem Steel Co.
	50	50-ton rack	Greenville Steel Car Co.
British American Oil Co., Ltd.	5	Tank	Canadian Car & Fdry. Co.
	24	Tank	National Steel Car Corp.
Canadian National	700*	45-ton box	Eastern Car Co.
	700*	45-ton box	National Steel Car Corp.
	600*	45-ton box	Canadian Car & Fdry. Co.
Canadian Pacific	1,000	40-ton box	Canadian Car & Fdry. Co.
	50	Automobile	Canadian Car & Fdry. Co.
	200	Flat	Canadian Car & Fdry. Co.
	200	Stone	Canadian Car & Fdry. Co.
	950	40-ton box	National Steel Car Corp.
	100	Gondola	National Steel Car Corp.
	200	50-ton hopper	National Steel Car Corp.
	50	Concentrate	Eastern Car Co.
	50	Refrigerator	Canadian Pacific shops
Canfield Tank Line	4	Tank	General American Trans. Co.
Niagara Smelting Corp.	1	Tank	General American Trans. Co.
Phillips Petroleum Co.	10	Propane tank	General American Trans. Co.
Shell Chemical Co.	4	Tank	General American Trans. Co.
U. S. Navy Dept.	5	50-ton flat	American Car & Fdry. Co.
	1	100-ton flat	Haffner-Thrall Car Co.
	1	50-ton hopper	American Car & Fdry. Co.

FREIGHT-CAR INQUIRIES

Eastern Gas & Fuel Associates	50	50-70-ton hopper	
	5–10	Tank	

PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Bangor & Aroostook†	1	Baggage and mail	Pullman-Std. Car Mfg. Co.

* These cars, which will be steel-sheathed, with wood linings and ceilings, will be wider and higher than the 3,000 built last year. They will have a length of 40 ft. 6 in., and will be 9 ft. 2 in. wide and 10 ft. high, with a capacity of more than 3,700 cu. ft. The weight of the car will be 1,700 lb. lighter than the previous lot.

† Ordered by Bangor & Aroostook Investment Co.

THE MAINTENANCE-OF-WAY ENGINEER

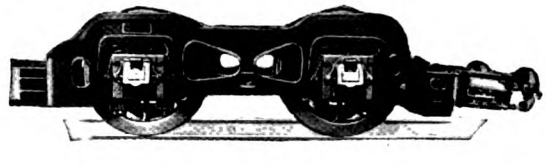


With increased speeds, track structures are suffering. A driving wheel load which is satisfactory at 60 miles per hour becomes questionable at 90 miles per hour. The factor of safety in track structures is endangered.

Lighter driving wheel loading is the solution and a new approach to locomotive design can supply it.

The solution incorporates the use of lighter driving wheel loads combined with the use of the Locomotive Booster, thus restoring the starting and accelerating power and making it equal to, or greater than, the heavier, costlier and more destructive design.

The net result is a high-speed, high-capacity locomotive that lightens the punishment on track, thereby reducing maintenance.



When maintenance is required, a replacement part assumes importance equal to that of the device itself and should be purchased with equal care. Use only genuine Franklin repair parts in Franklin equipment.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

opinion that Congress had made no exception of those employed in inspecting cars and that the statute expressly excludes the legal defense of assumption of risk, the Court concluded that "one is not to be denied the benefit of the Act because the work was that of inspection for the purpose of discovering defects." The opinion was rendered by Chief Justice Hughes.

Relation Between Track and Rolling Stock

THE Engineering Division (A. R. E. A.) and the Mechanical Division of the Association of American Railroads have appointed a joint committee to study the relation between track and rolling stock through a program of investigation and tests relating thereto. The committee is headed by Dr. Arthur N. Talbot, professor emeritus, University of Illinois, Urbana, Ill. Representatives of the A. R. E. A. include J. V. Neubert, chief engineer maintenance of way, N. Y. C., New York; W. J. Burton, assistant to chief engineer, M. P., St. Louis, Mo.; A. N. Reece, chief engineer, K. C. S., Kansas City, Mo.; and Robert Faries, assistant chief engineer, maintenance, Penna., Philadelphia, Pa.

The Mechanical Division has appointed the following: R. H. Kueck, chief mechanical engineer, M. P., St. Louis, Mo.; J. B. Blackburn, mechanical assistant to chief mechanical officer, C. & O., Cleveland, Ohio; J. G. Blunt, chief mechanical engineer, American Locomotive Co., Schenectady, N. Y.; F. A. Isaacson, engineer car construction, A. T. & S. F., Topeka, Kan.; and A. G. Hoppe, assistant mechanical engineer, C. M. St. P. & P., Milwaukee, Wis. W. I. Cantley, mechanical engineer, Mechanical Division, and G. M. Magee, research engineer, Engineering Division, will participate ex-officio in the activities of the committee.

Employment Still Dropping

RAILWAY employment fell off another 2.08 per cent during the one-month period from mid-January to mid-February, according to the Interstate Commerce Commission's compilation, based on preliminary reports. The total number of employees as of the middle of February was 939,663, as compared with a mid-January figure of 959,670.

The drop in maintenance of equipment and stores forces was 3.33 per cent while the train and engine service group was down 2.87 per cent, reflecting the fall in traffic. The mid-February maintenance of way and structures force was 1.31 per cent smaller than that of the previous month.

The drop in total employment as compared with February, 1937, was 14.26 per cent, with maintenance of way and structures forces falling off 19.3 per cent; maintenance of equipment and stores, 21.54 per cent; and train and engine service, 13.86 per cent. The index number, based on the 1923-1925 average as 100 and corrected for seasonal variation, stood at 54.7 in February as compared with 63.8 in February, 1937.

Rock Island Leases Diesel-Electric Power

THE CHICAGO, ROCK ISLAND & PACIFIC has, with the consent of the federal district court at Chicago, completed negotiations with the Electro-Motive Corporation for the lease of 10 Diesel-electric switching locomotives for a period of seven years. The locomotives include eight 100-ton, 600-hp. and two 125-ton, 900-hp. locomotives. The gross rental for each of the 100-ton locomotives will be $67,500 and the total rental on the larger ones will be $88,000 each. At the conclusion of the rental period, the road may purchase the locomotives at a nominal cost. The petition of the road to the court stated that ten Diesel switching locomotives, similar to the 100-ton locomotives just obtained, were leased from the Electro-Motive Corporation on April 20, 1937, resulting in a savings of approximately $1,000 a month to the road after the payment of rental.

Fuel Efficiency Record in 1937

AN improved record in fuel efficiency by locomotives engaged in road and yard service was established by the railroads of the United States in 1937, according to the Association of American Railroads. In that year an average of 117 lb. of fuel was required to haul 1,000 tons of freight and equipment a distance of one mile. This was the lowest average attained since the compilation of these reports began in 1918.

The average in 1937 was a reduction of nearly 28 per cent compared with 1921, in which year the average was 162 lb. It also was a reduction of 2 lb. compared with 1936 and a reduction of 3 lb. compared with 1935.

Increased efficiency in fuel consumption in passenger service also took place in 1937. In that year, 15.1 lb. of fuel were required to haul each passenger-train car one mile. This was a reduction of nearly 15 per cent compared with 1921 when the average was 17.7 lb. The average in 1936 was 15.3 lb. and in 1935 it was 15.5 lb.

Class I roads in 1937 used 82,276,671 tons of coal for both road and yard switching service. This was obtained at a cost of $198,953,973. In 1936, they used 80,439,186 tons, the cost of which was $188,572,369. The railroads also consumed in road and yard switching service in 1937, 2,553,723,894 gal. of fuel oil, compared with 2,336,421,839 gal. in 1936.

Equipment Depreciation Orders

EQUIPMENT depreciation rates for six railroads, including the Virginian and the Clinchfield, have been prescribed by the Interstate Commerce Commission in another series of sub-orders modifying previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies. The composite percentages which are not prescribed rates range from 3.07 per cent for the Clinchfield to 11.94 per cent for the Sabine & Neches Valley.

The Virginian's composite percentage of 3.26 is derived from the following prescribed rates: Steam locomotives, 3.65 per cent; other locomotives, 2.82 per cent; freight-train cars, 3.25 per cent; passenger-train cars, 3 per cent; work equipment, 3.87 per cent; miscellaneous equipment, 15 per cent. Prescribed rates for the Clinchfield are: Steam locomotives, 3.21 per cent; freight-train cars, 3 per cent; passenger-train cars, 3.14 per cent; work equipment, 2.81 per cent.

Illinois Central Adopts Plan to Reduce Payroll Expense

A PLAN providing for the reduction of payroll expense by the elimination of positions and by vacations without pay has been placed in effect by the Illinois Central. Under the plan all employees, including officers, will contribute to the payroll reduction so that no particular group will be called upon to bear the entire burden. In that group of employees which enjoys wage and working contracts through the Brotherhoods, a ten per cent reduction in payroll is being accomplished through the elimination of positions. In the group of employees not covered by contracts, including officers not under contract, each employee is required to take ten days vacation without pay during April or May at such time as the employee chooses and work permits. The ten days may or may not be consecutive.

Supply Trade Notes

THE MODERN SUPPLY COMPANY, Chicago, has been appointed sales representative for the Standard Brake Shoe & Foundry Company, Pine Bluff, Ark.

◆

GEORGE KEMME, railway sales and service engineer for the Standard Oil Company, Minneapolis division, with headquarters at Minneapolis, Minn., has retired.

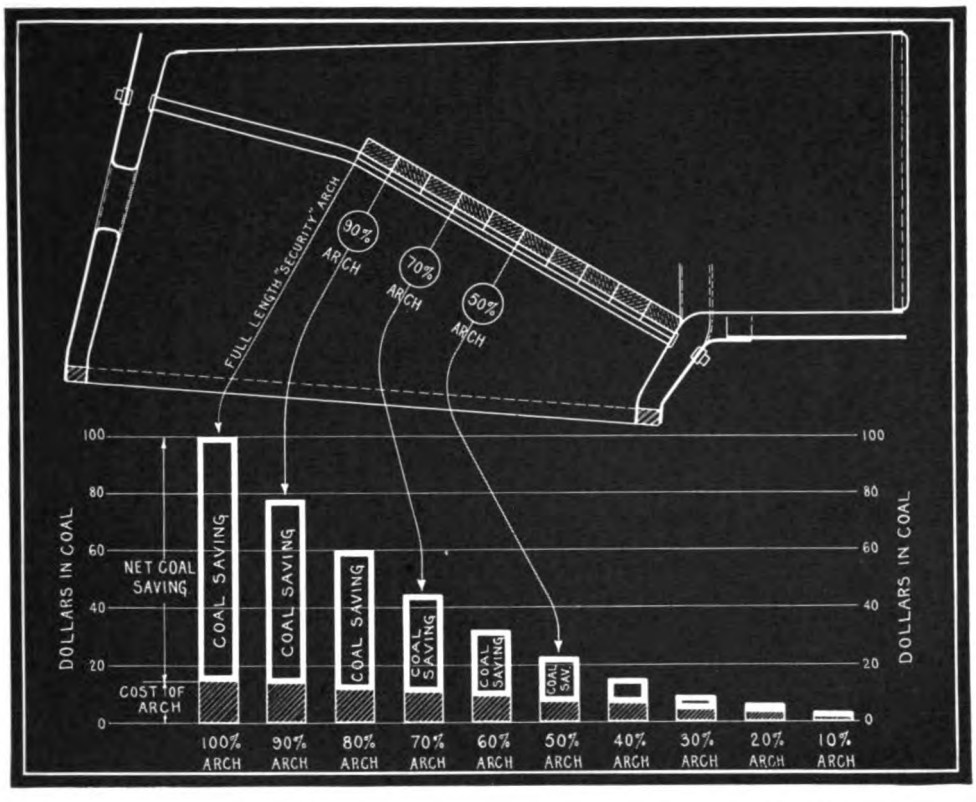
H. E. LEWIS, chairman of the board of the Jones & Laughlin Steel Corporation, Pittsburgh, Pa., has also been elected president to succeed S. E. Hackett, resigned. Lewis M. Parson, who has been in charge of the Philadelphia sales office of the Bethlehem Steel Company, has been elected a director and vice-president in charge of sales of the Jones & Laughlin Steel Corporation.

J. W. KEARNEY recently became associated with the Davis Brake Beam Company, Johnstown, Pa. Mr. Kearney's headquarters are at 908 Midland building, Cleveland, Ohio.

◆

C. C. SCOTT, manager of the Buffalo, N. Y., sales office of the Worthington

(*Continued on next left-hand page*)



THE EFFECT OF ABBREVIATED ARCHES ON FUEL SAVING

LET THE ARCH HELP YOU SAVE

With the emphasis being placed on saving every railroad dollar, the locomotive Arch becomes increasingly important.

Regardless of the amount of traffic handled, the locomotive Arch saves enough fuel to pay for itself ten times over.

Be sure that every locomotive leaving the roundhouse has its Arch complete with not a single brick nor a single course missing.

In this way, you will get more work for each dollar of fuel expense. Skimping on Arch Brick results in a net loss to the railroad.

THERE'S MORE TO SECURITY ARCHES THAN JUST BRICK

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

Pump and Machinery Corporation, Harrison, N. J., has been assigned to special work in the Buffalo district and has been succeeded by W. A. Meiter, representative for the Cleveland, Ohio, territory.

◆

THE WILSON ENGINEERING CORPORATION, Chicago, has been appointed distributor for the railway equipment manufactured by The Unit Heater & Cooler Co., Wausau, Wis., a division of the D. J. Murray Manufacturing Company of the same city.

◆

FRANK P. MCEWEN, formerly with the Republic Steel Corporation, has been elected vice-president and assistant to president of the Ewald Iron Company, with headquarters at Louisville, Ky., to succeed George O. Boomer, resigned.

◆

JAMES T. HAMILTON has been appointed district manager, Eastern division of the Railway division of the Dayton Rubber Manufacturing Company, Dayton, Ohio, and Charles F. Howard, who has had practical experience on railway air conditioning equipment, has been appointed service inspector in the Eastern region for the railway division. Mr. Hamilton, after graduating from Bliss Electrical School, Washington, D. C., served as a special apprentice on the New York, New Haven & Hartford. In 1920 he resigned as assist-



J. T. Hamilton

ant mechanical superintendent and assumed charge of rolling stock on the New York, Westchester & Boston as superintendent of car equipment, but later left this road to become car equipment engineer with Jackson & Moreland, consulting engineers on the Delaware, Lackawanna & Western electrification. On completion of this project, he entered the sales field as eastern railway sales manager for a storage battery company. He then assisted in organizing the car maintenance department of the City of New York Independent System, and later in the maintenance of its car equipment.

◆

J. M. TAYLOR, vice-president and manager at New Orleans, La., of the New Orleans Building Materials District of the Johns-Manville Sales Corporation has been transferred from the management of that district to the staff of the president of the sales corporation, with headquarters, as formerly, at New Orleans. Mr. Taylor continues as vice-president of the sales corporation, but has been relieved of the duties of district managership to devote more of his time to this special assignment.

◆

LEWIS M. PARSONS, formerly manager of sales of the Bethlehem Steel Company, with headquarters at Philadelphia, Pa., has been elected vice-president in charge of sales and a director of the Jones & Laughlin Steel Corp., Pittsburgh, Pa.



Lewis M. Parsons

Mr. Parsons was educated at the University of Pennsylvania and in 1917 entered the destroyer service of the U. S. Navy. Later in the World War he served in the Naval Flying Corps. After the war, he entered the employ of the Bethlehem Steel Company in the sales division and was made assistant manager of sales at Philadelphia in 1932. In 1936 he became manager of sales at the same office.

◆

A NEW board of directors of The Baldwin Locomotive Works was elected at the annual meeting of the company held at Philadelphia, Pa., on March 3. The board elected at the meeting, the first to be held since confirmation of the reorganization plan, is made up as follows: Arnold Bernhard, of New York; Charles E. Brinley, John W. Converse, Joseph N. Ewing, Edward Hopkinson, Jr., George H. Houston, Conrad N. Lauer, all of Philadelphia; Jerome Preston, of Boston, Mass.; Charles H. Schlacks, of Philadelphia; Robert C. Shields, of Detroit, Mich.; Charles L. Stillman, of New York; and Samuel M. Vauclain, of Philadelphia.

The new members of the board are Messrs. Bernhard and Brinley, who are also voting trustees; Converse, Hopkinson, Preston, Schlacks and Stillman.

At the organization meeting of the board, held on March 7, the following officers were re-elected to serve for the ensuing year: Samuel M. Vauclain, chairman of the board; George H. Houston, president; Robert S. Binkerd, vice-president and director of sales; Harry Glaenzer, vice-president in charge of engineering; Charles E. Acker, treasurer; Charles D. MacGillivray, secretary; James Macdonald, assistant secretary; Howard D. Humphrey and Thomas E. McFalls, assistant treasurers.

In addition the following executive committee was elected: Conrad N. Lauer, chairman, Arnold Bernhard, Charles E. Brinley, Edward Hopkinson, Jr., George H. Houston, Robert C. Shields, and Samuel M. Vauclain.

◆

F. B. HORSTMANN has been appointed technical director, railroad department, of the Dearborn Chemical Company, Chicago, with duties to include the general supervision of all railroad department matters falling under that head.

◆

GEORGE T. MAHANEY of the staff of the general sales manager of the Chevrolet Motor division of the General Motors Corporation and James D. Platt, district manager of the Pontiac Motor division, with headquarters at Seattle, Wash., have been appointed eastern and western sales managers, respectively, of the Diesel Engine division of General Motors Sales Corporation, with headquarters in Cleveland, Ohio. The two territories will be divided roughly by a line extending from Mobile, Ala., northward through Chicago and Milwaukee, Wis.

◆

J. A. AMOS, vice-president of the Pyle-National Company, Chicago, has been elected president to succeed William Miller, who has been elected chairman of the board. Mr. Amos has been with the Pyle-National Company since 1926, when he entered its employ as vice-president. Prior to that time he was associated with various companies until 1918, when he established the Oliver Electric Appliance Company,



J. A. Amos

at St. Louis. In 1924, this company was sold to the Pyle-National Company and was operated as an independent business until 1926, when it was merged with Pyle-National and Mr. Amos was elected vice-president.

Mr. Miller's experience embraces several years of railroad service prior to 1908, when he became vice-president of the Adreon Manufacturing Company. Three years

(*Continued on next left-hand page*)

Some of the Advantages

of the *New* 4-8-4 Type Locomotives for the C. M. St. P. & P. R. R. Co.

More Hp. Per Unit of Weight and Size

This efficiency is obtained with a boiler equipped with an Elesco Type "E" superheater. A locomotive boiler equipped with a Type "E" superheater as compared with a Type "A" superheater, effects a substantial increase in evaporative capacity and 50%-80% more superheating capacity.

The ability of the superheater to provide high degrees of superheated steam, however, is dependent upon the entering steam being free of moisture. The Elesco tangential steam dryer assures the flow of dry steam to the superheater. The dryer is attached to the inlet of the dry pipe and separates the moisture from the steam through centrifugal motion, and automatically returns the moisture back to the boiler. The inlet of the dryer is unobstructed and is at the highest point in the dome.

A Smooth Acting and Warp-Proof Throttle

The small steel valves of the American multiple-valve throttle operate at progressive intervals, which insure perfect gradation of the steam to the locomotive cylinders.

The small valves, not being affected by high steam temperatures, insure a DEPENDABLE throttle. The throttle is cast integral with the superheated steam compartment of the superheater header and, as compared with other types of throttles, substantially economizes on weight, space and flanged steam joints.

ELESCO

A-1224

THE SUPERHEATER COMPANY

Representative of AMERICAN THROTTLE COMPANY, INC.
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later he was elected president of the Monarch Pneumatic Tool Company and vice-president of the Standard Railway Equipment Company, from which position he resigned in 1913 to become vice-president



William Miller

of the Pyle-National Company. In 1914 he was elected senior vice-president and on August 2, 1934, was elected president, which position he has held until his recent appointment.

THE T-Z RAILWAY EQUIPMENT COMPANY, Chicago, has been appointed national sales representative for the distribution of railway specialties manufactured by the Motor Wheel Corporation, Lansing, Mich., which includes primarily steel car stampings, such as coil-spring plates, journal-box lids, dust-guard assemblies, triple-valve protector caps and defect- and routing-card holders.

◆

THE officers of the Greenville Steel Car Company, Greenville, Pa., are now as follows: Edwin Hodge, Jr., of Pittsburgh, chairman and president, succeeding Frank L. Fay, who has resigned; W. S. Dietrich, vice-president in charge of operation; K. C. Gardner, continues as vice-president in charge of sales; R. A. Zimmerman is treasurer and assistant secretary, and John C. Bane, Jr., is secretary and assistant treasurer.

Obituary

CORNELIUS G. SAUERBERG, mechanical representative of the Ohio Injector Company of Illinois, Chicago, with headquarters at Castleton-On-Hudson N. Y., died in Mason City, Iowa, on February 24. He was born on January 13, 1884, and graduated from Iowa State College in 1911. Following his graduation he entered the employ of the Atchison, Topeka & Santa Fe, serving in various capacities in the mechanical department of that railroad until 1919, when he engaged in business for himself in Mason City. In September, 1924, he was employed by the Ohio Injector Company of Illinois as mechanical representative and service engineer, at Castleton-On-Hudson.

◆

ROBERT R. WELLS, representative for the western territory of the Hunt-Spiller Manufacturing Corporation, South Boston, Mass., died on February 23, of a heart ailment at his home in Berkeley, Calif. Mr. Wells was born at Topeka, Kan., on February 7, 1885, and during his early career was employed by the Atchison, Topeka & Santa Fe. He subsequently was an inspector at the steel plants in Chicago and then was with the United States Metallic Packing Company previous to March 15, 1923, when he entered the service of the Hunt-Spiller Manufacturing Corporation as a representative in its sales department for the western territory.

Personal Mention

General

R. V. BLOCKER, assistant superintendent of motive power of the Erie, with headquarters at Cleveland, Ohio, has been appointed superintendent of motive power to succeed Charles James, retired.

W. E. HARMISON, master mechanic of the Erie at Hornell, N. Y., has been promoted to assistant to the superintendent of motive power, with the same headquarters. The position of assistant superintendent of motive power has been abolished.

CHARLES JAMES, superintendent of motive power of the Erie at Cleveland, Ohio, has retired. Mr. James was born in Elkhart, Ind. Before coming to the Erie as a machinist in 1890 he had spent ten years in the Elkhart shops of the Lake Shore & Michigan Southern (now part of the New York Central). On the Erie he became enginehouse foreman at Huntington, Ind., and later general foreman at Chicago. After serving as master mechanic at Avon, N. Y.; Galion, Ohio; Port Jervis, N. Y., and Jersey City, N. J., he became district mechanical superintendent of the Western district, later being transferred to the Hornell region. He was appointed superintendent of motive power on November 1, 1927.

J. M. NICHOLSON, acting mechanical superintendent of the Western mechanical district of the Eastern lines of the Atchison, Topeka & Santa Fe, has been appointed mechanical superintendent of the same territory, with headquarters as before at Topeka, Kan., succeeding I. C. Hicks, who is retiring at his own request, after 35 years' service with this company. Mr. Nicholson was born in Scranton, Kan., on February 24, 1888. After graduating from Kansas State College he entered the test department of the Santa Fe on September



J. M. Nicholson

16, 1912, as a computer. In June, 1913, he was promoted to an assistant in this department, and on May 1, 1916, to laboratory foreman. The following August he was made fuel supervisor on the Missouri and Illinois divisions. He was promoted to assistant engineer of tests on May 26, 1921, and became fuel conservation engineer for the system on January 1, 1923. Mr. Nicholson was promoted to master mechanic on November 1, 1930, serving first on the Slaton division, then, after February 1, 1934, on the Eastern and Kansas City divisions, and, after July 1, 1937, on the Illinois division. He was appointed acting mechanical superintendent of the western district of the Eastern lines on July 20, 1937.

Master Mechanics and Road Foremen

EDWARD POOL, master mechanic of the Erie at Marion, Ohio, has been appointed master mechanic at Hornell, N. Y.

CHESTER K. JAMES has become master mechanic of motor equipment of the Erie, with headquarters at Hornell, N. Y.

C. J. GERBES, master mechanic of the Erie at Avoca, Pa., has been appointed master mechanic at Marion, Ohio.

HARVEY H. JONES has been appointed master mechanic of the Wyoming division of the Union Pacific, with headquarters at Cheyenne, Wyo., succeeding R. F. Weiss.

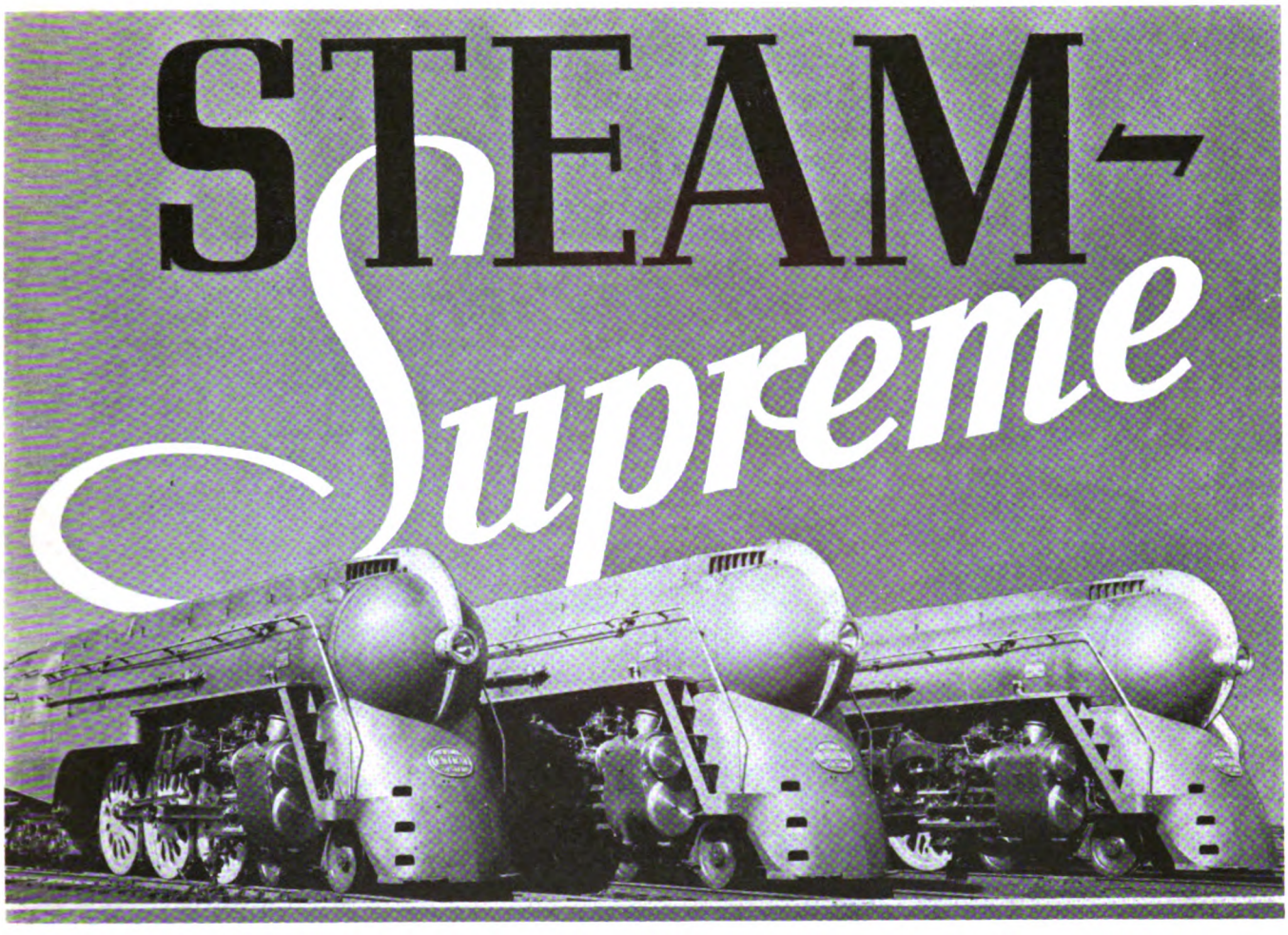
LESLIE FORAKER has been appointed road foreman of engines on the Susquehanna division of the Erie, succeeding L. D. Burdell.

C. W. ECENBARGER, general enginehouse foreman of the Erie at Port Jervis, N. Y., has been promoted to the position of master mechanic at Avoca, Pa., to succeed C. J. Gerbes.

L. D. BURDELL has been appointed road foreman of engines on the Meadville and B. & S. W. divisions of the Erie.

B. E. JONES, master mechanic of motor equipment of the Erie, with headquarters

(*Continued on next left-hand page*)



On the New York Central

WHEN it came to motive power for the new deluxe streamlined 20th Century Limited, the New York Central demonstrated their implicit confidence in steam by again selecting the reliable time-tested, service-proved Hudson type locomotive. And why not?—For twelve years this fast passenger locomotive, hauling all the famous trains of the New York Central, has been making most exacting schedules with sunrise certainty. Now, with this long continued success with steam, 50 more improved Hudsons, ten of which are attractively streamlined for the Century, are being delivered, raising the total number of Hudsons on the Central to 275.

The construction of these 275 engines brought continued improvements in both proportions and mechanical details making each successive class of Hudsons more powerful, efficient and serviceable than the one before. These new engines develop more than 4,700 cylinder horsepower at 75 miles per hour. At 80 miles per hour they produce a drawbar pull of 17,500 pounds or 30 per cent more than the pull exerted by previous Hudsons at the same speed. Most important of all, this outstanding performance is delivered at a relatively low first cost.

Steam is still supreme on the New York Central.

AMERICAN LOCOMOTIVE COMPANY

50 CHURCH STREET · NEW YORK · N.Y.

at Hornell, N. Y., has been appointed master mechanic at Buffalo, N. Y., to succeed William Moore.

Car Department

JAMES F. MONGER, who has been appointed superintendent of the car shops of the Illinois Central at Burnside (Chicago), as noted in the December issue of the *Railway Mechanical Engineer*, was born in Loudon County, Tenn., on September 6, 1885. He received a grammar school education and entered railway service on September 1, 1912, as a gang foreman with the Illinois Central & Yazoo & Mississippi Valley at Memphis, Tenn. On May 1, 1917, he became a general car foreman at Vicksburg, Miss., and on March 16, 1934, general car foreman at Burnside. On November 1, 1937, Mr. Monger was appointed shop superintendent.



J. F. Monger

EDWARD M. JENKINS, master car builder of the Delaware, Lackawanna & Western at Scranton, Pa., has retired.

FRANK A. SHOULTY has recently been appointed assistant superintendent of the car department of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Milwaukee, Wis.

ROLAND H. LLOY, car foreman of the Canadian National at Halifax, N. S., has been appointed acting general car foreman, succeeding W. H. Pirie.

Shop and Enginehouse

F. D. RIPLEY, assistant foreman of the Norfolk & Western at Eckman, W. Va., has been promoted to the position of foreman, succeeding W. H. Show.

ALEXANDER D. MCDONALD, night enginehouse foreman of the Canadian National at Mulgrave, N. S., has become acting day foreman of the enginehouse.

WILLIAM MOORE, master mechanic of the Erie at Buffalo, N. Y., has been appointed shop superintendent, with headquarters at Hornell, N. Y.

J. R. HARRIS has been appointed production engineer of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Milwaukee, Wis.

R. M. WILSON has been appointed general foreman of the Erie at Port Jervis, N. Y., succeeding C. W. Ecenbarger.

JAMES E. STANTON, boilermaker of the Canadian National at Mulgrave, N. S., has been appointed acting night foreman.

EARL C. KELLOCK has been appointed acting enginehouse foreman of the Canadian National, with headquarters at Stellarton, N. S., succeeding James Blair, who has retired.

Obituary

G. W. ROBERTSON, master mechanic of the Chesapeake & Ohio at Clifton Forge, Va., died on February 9.

GEORGE TOZZER, who retired as purchasing agent of the Big Four in 1917, died in Cincinnati, Ohio, January 22, at the age of 87.

J. G. HILGEN, division storekeeper of the Chesapeake & Ohio, with headquarters at the Russell car shops, Russell, Ky., died suddenly at his home on February 1, at the age of 48 years.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

LANDIS HYDRAULIC GRINDER.—The Landis 16-in. Type B plain hydraulic grinder is illustrated and described in Catalog E-37 issued by the Landis Tool Company, Waynesboro, Pa.

◆

NICKEL ALLOY STEELS FOR HAND TOOLS.—Bulletin U-3, issued by The International Nickel Company, Inc., 67 Wall street, New York, describes nickel alloy steels for hand tools and small power tools, such as wrenches, hammers, screw drivers, pliers, chisels, rivet sets, punches, etc.

◆

VANADIUM STEEL CASTINGS.—The 24-page illustrated bulletin issued by the Vanadium Corporation of America, 420 Lexington avenue, New York, contains a complete description of the properties and applications of a number of vanadium alloy steels for castings where high strength is required without excessive weight or high cost. Carbon-vanadium steel, manganese-vanadium steel, nickel-vanadium steel and nitriding cast steel are among the alloy steels discussed.

◆

MONEL, NICKEL *and* NICKEL ALLOYS.—Bulletins T13 and T-14, issued by the Development and Research Division of the International Nickel Company, Inc., 67 Wall street, New York, discuss, respectively, nickel and nickel-base alloys—their use in the design of corrosion-resistant machinery and equipment, and the design and construction of heavy equipment in monel, nickel and Inconel.

◆

MACHINING ALUMINUM.—Part I of the completely revised edition of "Machining Aluminum," issued by the Aluminum Company of America, Pittsburgh, Pa., deals with cutting angles and shapes for various tools for general machine-shop practice, and discusses cutting speeds, feeds, lubricants and tool materials. Part II is concerned with speeds, feeds, cutting compounds, tool materials and various tools used for screw-machine practice.

◆

TURRET LATHES.—A 20-page booklet, being distributed by the Gisholt Machine Company, Madison, Wis., gives a pictorial record and general description of the complete line of turret lathes manufactured by this company. As described in the booklet, these machines range from the No. 3 universal ram-type turret lathe, having a 1½-in. spindle bore to the largest No. 5L heavy-duty type, having a 12¼-in. spindle bore. Two types of automatic lathes, static and dynamic balancers, a tool-grinding machine, also chucks, machine attachments, boring bars, etc., are described. The unit structural features in the design of these turret lathes are clearly illustrated and their advantages pointed out. Another 24-page catalog illustrates Gisholt standard tools for 1L and 2L high-production turret lathes.

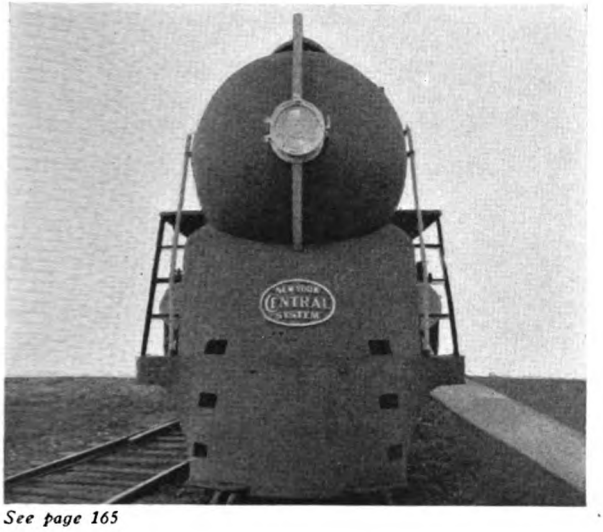
◆

TIMKEN ENGINEERING JOURNAL.—The fifth edition of The Timken Engineering Journal, issued by The Timken Roller Bearing Company, Canton, Ohio, contains a complete revision of the General Information Section. The volume of 294 loose-leaf pages, furnished in a standard 8½-in. by 11-in. three-ring binder, with stiff covers, includes a general discussion of the types of Timken bearings now available, a discussion of ratings and bearing selection, methods used for calculating bearing loads for a wide range of fundamental applications, and complete detailed information as to bearing sizes and load-carrying capacity. Full- and half-size detail bearing drawings for single-row Timken bearings up to an outside diameter of 14 in. are also presented. Supplementary sections cover applications in such special fields as conveyors, shop trucks, oil field equipment, etc.

RAILWAY MECHANICAL ENGINEER

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.



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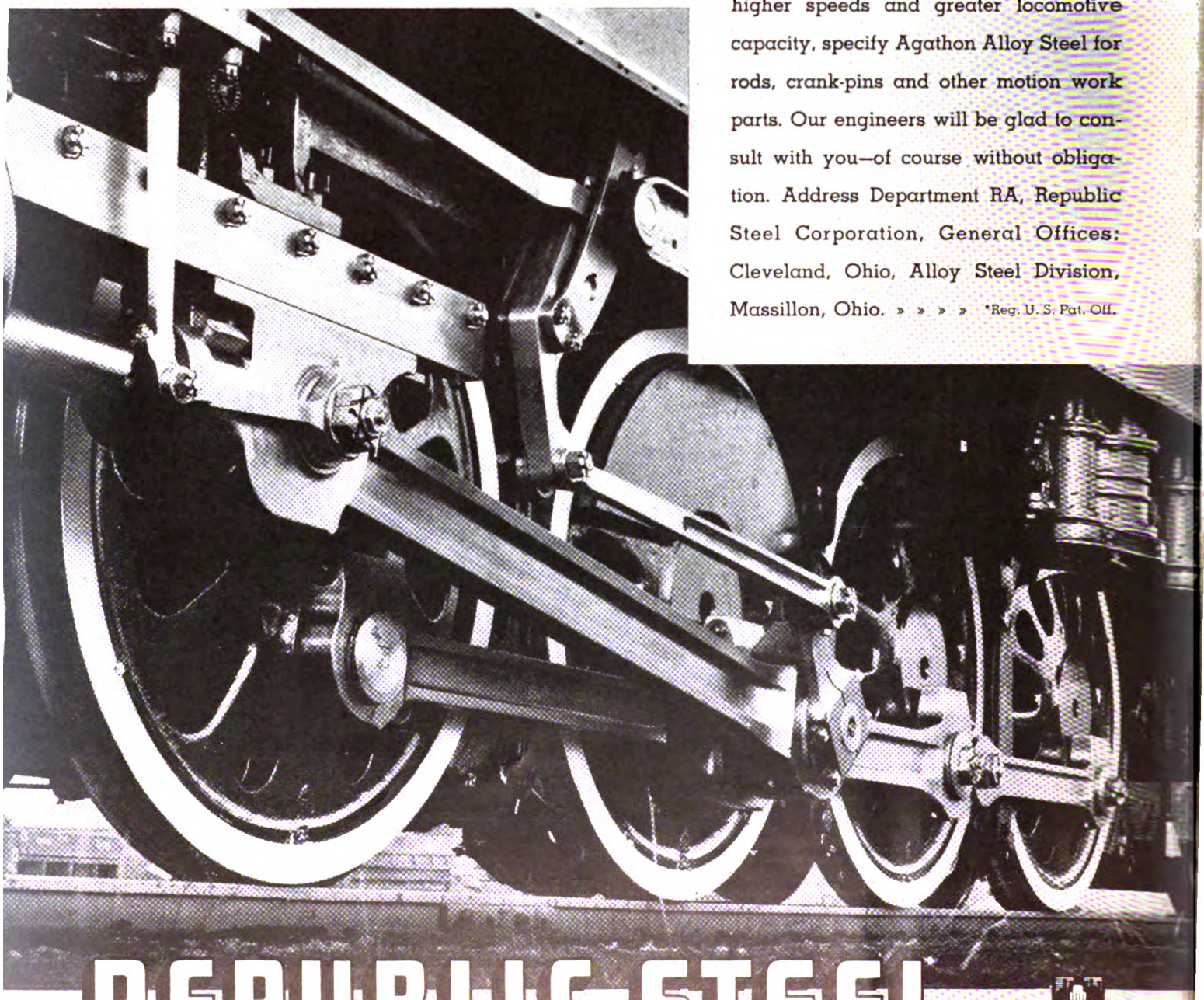
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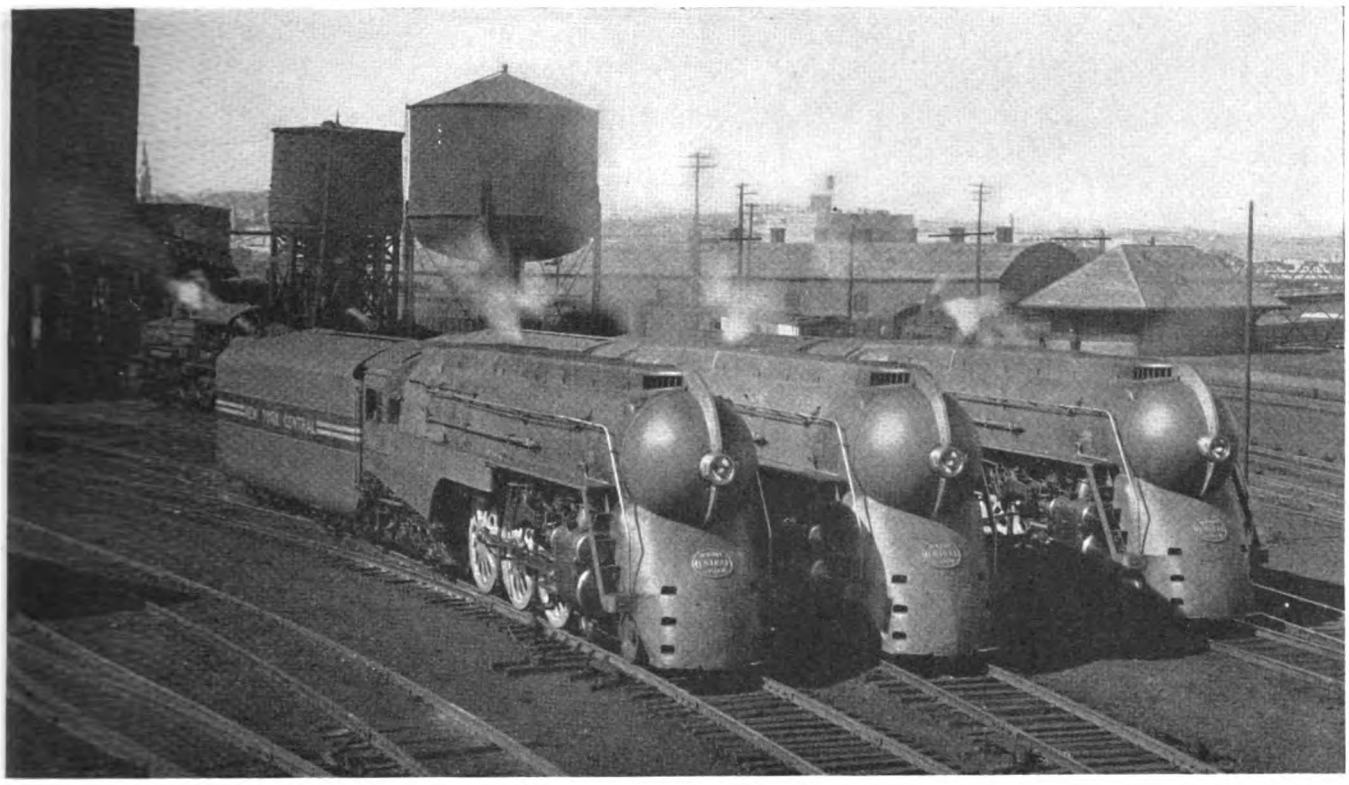
With 72-inch drivers moving at 70 miles per hour the rail gets a hammer blow 5½ times a second; how heavy and costly this blow is depends on the weight of the reciprocating and revolving parts. » » » With light weight parts of Agathon* Alloy Steel this hammer blow is minimized. Maintenance of both engine and track is correspondingly reduced and higher speeds can be used with greater safety. » » » Agathon Alloy Steel has high tensile strength and high resistance to vibration and shock. » » » In designing for higher speeds and greater locomotive capacity, specify Agathon Alloy Steel for rods, crank-pins and other motion work parts. Our engineers will be glad to consult with you—of course without obligation. Address Department RA, Republic Steel Corporation, General Offices: Cleveland, Ohio, Alloy Steel Division, Massillon, Ohio. » » » » *Reg. U. S. Pat. Off.



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The New York Central Receives Fifty

Powerful 4-6-4 Locomotives

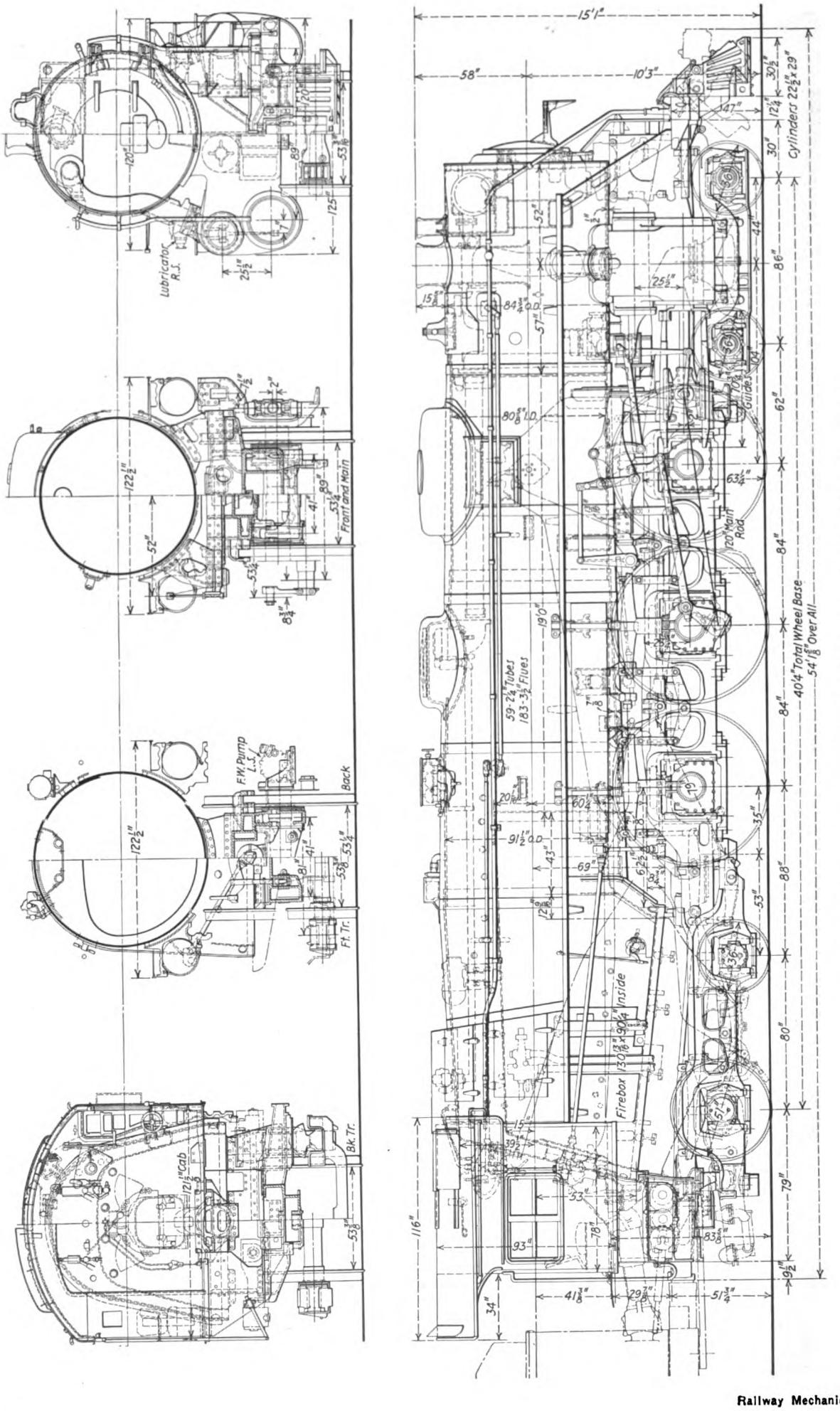
These locomotives, built by American, develop a total tractive force of 55,540 lb. and a maximum drawbar horsepower of 3,380 at 65 m. p. h.—The boilers have combustion chambers and all-welded fireboxes

SINCE the latter part of 1937 the New York Central has been taking delivery from the American Locomotive Company of an order of 50 locomotives of the 4-6-4 type, the last 10 of which are streamline. These locomotives, which are known as the J-3a class, are similar in general design to the earlier 4-6-4 type locomotives of the J-1 class, the first of which were delivered to the New York Central by the same builder in 1927. In mechanical details, as well as in boiler proportions, however, the design is characterized by distinct refinements. The weight of the new locomotives has been increased by four-tenths of one per cent and the weight on drivers by about three per cent, as compared with the most recent J-1 design. The boiler proportions have been materially changed by the insertion of a 43-in. combustion chamber and by reducing the length of the smokebox to permit moving the tube sheet 25 in. forward. The length over the tube sheets has been reduced by 18 in. to 19 ft. and the boiler pressure has been increased from 225 lb. to 275 lb. per sq. in. The boiler courses are alloy steel.

The Boiler

With the insertion of the combustion chamber the form of the boiler has been slightly changed from the straight-top type employed in the J-1 locomotives. The inside diameter of the first course has been reduced $1\frac{13}{16}$ in. to $80\frac{5}{8}$ in. The second course is conical. The outside diameter of the third course has been increased $3\frac{7}{8}$ in. to $91\frac{1}{2}$ in. The tube-sheet layout has been modified by the installation of a larger number of $2\frac{1}{4}$-in. tubes without, however, essentially changing the number of units in the Type E superheater. The reduction in the length of the tubes, however, has effected a reduction in superheating surface. The shell courses, the welt strips and the dome liner are of nickel steel. The first course is $\frac{13}{16}$ in. in thickness and the others, $\frac{7}{8}$ in. in thickness. The dome, which is on the conical course, is flanged of carbon steel. The wrapper sheet is $\frac{31}{32}$ in. in thickness and the outside side sheets and back head, $\frac{9}{16}$ in.

The inside firebox is completely welded. This includes the tube sheet and door sheet to the crown and side sheets, the door sheet to the back head at the fire-door ring, the crown to the side sheets and the throat sheet to the firebox sheets and combustion chamber. These seams are all joined by butt welding inside and outside.



Elevation and cross-sections of the New York Central Class J-3a 4-6-4 type locomotives

The inside and outside side sheets are welded to the mud ring at the corners, and the outside sheet calking edges at both the throat-sheet and back-head seams are welded above the sixth row of staybolts from the mud ring.

Both the front-tube-sheet and the back-head bracing are in the form of gussets, except for three points on the tube sheet and two points on the back head where clearances made necessary the use of rods. The back-head gussets are flanged and riveted directly to the wrapper sheet. The tube-sheet gussets are attached by angles to both the shell and the tube sheet itself.

The fireboxes have extensive installations of F. B. C. telltale type flexible stays. These include all crown stays except the middle six rows, the entire back head, throat sheet and side sheets, except for the bottom row next to the mud ring. Except for certain locations where F. W. type sleeves are required for clearance, the U. W. sleeves are installed. There are four combustion tubes through each side of the firebox, each so located as to be opposite a staybolt on the other side of the firebox.

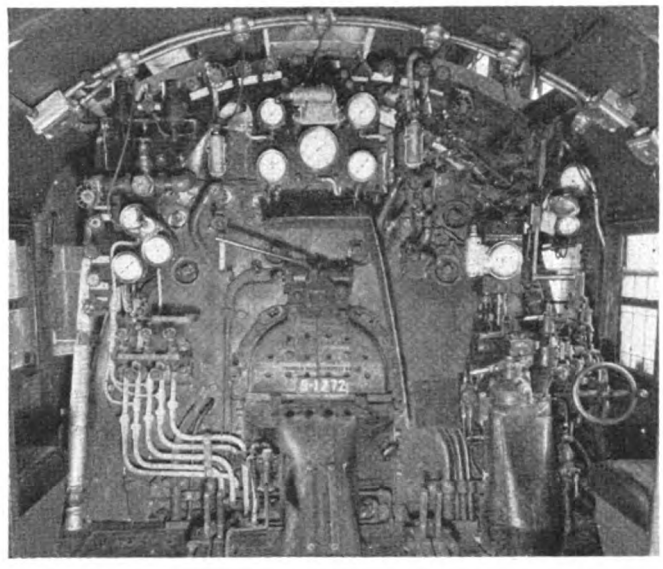
The brick arch is mounted on four arch tubes. The grates are of the Firebar type and coal is fed by a type HT Standard stoker. The stoker engine is mounted at the rear end of the locomotive.

The locomotive is equipped with the Elesco type K40 feedwater heater which is mounted within the top of the smokebox in front of the stack. Recesses within the smokebox shell are provided for feedwater-heater pipe connections. The spark arrester is of the box type enclosed with Draftac netting on the top and sides and with a solid bottom at the elevation of the top of the exhaust nozzle.

There are steam separators on the dry pipes on these locomotives, those on half of the locomotives being the Tangential type and those on the other half being of the Dri-Steam type. Barco low-water alarms are fitted on all of the boilers. The American multiple throttle is built into the superheater header.

General Dimensions, Weights and Proportions of the New York Central 4-6-4 Type Locomotives

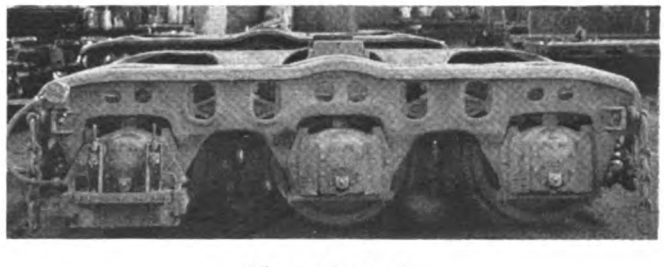
Railroad	New York Central
Builder	American Locomotive Co.
Type of locomotive	4-6-4
Road class	J-3a
Date built	1937
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	15-1
Height to center of boiler, ft. and in.	10-3
Width overall, in.	125
Cylinder centers, in.	89
Weights in working order, lb.:	
On drivers	196,000
On front truck	66,000
On trailing truck	98,000
Total engine	360,000
Tender	314,300
Wheel bases, ft. and in.:	
Driving	14-0
Rigid	14-0
Engine, total	40-4
Engine and tender, total	83-7½
Wheels, diameter outside tires, in.:	
Driving	79
Front truck	36
Trailing truck	36 and 51
Engine:	
Cylinders, number, diam. and stroke, in.	2-22½×29
Valve gear, type	Baker
Valves, piston type, size, in.	14
Maximum travel, in.	8½
Steam lap, in.	1⅝
Exhaust clearance, in.	3/16
Lead, in.	¼
Cut-off in full gear, per cent	85
Booster	Franklin Type C-2
Boiler:	
Type	Conical connection
Steam pressure, lb. per sq. in.	275
Diameter, first ring, inside, in.	80⅝
Diameter, largest, outside, in.	91½
Firebox length, in.	130 13/16
Firebox width, in.	90¼
Height mud ring to crown sheet, back, in.	68
Height mud ring to crown sheet, front, in.	89 1/16
Combustion chamber length, in.	43
Arch tubes, number and diam., in.	4-3½
Tubes, number and diam., in.	59-2¼
Flues, number and diameter	183-3½
Length over tube sheets, ft. and in.	19-0
Net gas area through tubes and flues, sq. ft.	8.93
Fuel	Bituminous
Stoker	Standard, type H-T
Grate type	Firebar, rocking
Grate area, sq. ft.	82
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	323
Arch tubes	37
Firebox, total	360
Tubes and flues	3,827
Evaporative, total	4,187
Superheating	1,745
Comb. evap. and superheat.	5,932
Feedwater heater, type	Elesco
Tender:	
Style or type	Rectangular water leg
Water capacity, gal.	14,000
Fuel capacity, tons	30
Trucks	Six-wheel
Journals, diam., in.	5.906
General data, estimated:	
Rated tractive force, engine, 85 per cent, lb.	43,440
Rated tractive force, booster	12,100
Total rated tractive force, lb.	55,540
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	54.45
Weight on drivers ÷ tractive force	4.51
Weight of engine ÷ evaporat. heat. surface	85.95
Weight of engine ÷ comb. heat. surface	60.69
Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	6.07
Tube-flue heat. surface, per cent comb. heat. surface	64.52
Superheat. surface, per cent comb. heat surface	29.42
Firebox heat. surface ÷ grate area	4.39
Tube-flue heat. surface ÷ grate area	46.68
Superheat. surface ÷ grate area	21.28
Comb. heat. surface ÷ grate area	72.38
Gas area, tubes-flues ÷ grate area	0.109
Evaporat. heat. surface ÷ grate area	51.06
Tractive force ÷ grate area	529.8
Tractive force ÷ evaporat. heat. surface	10.38
Tractive force ÷ comb. heat. surface	7.32
Tractive force × diam. drivers ÷ comb. heat. surface	578.5



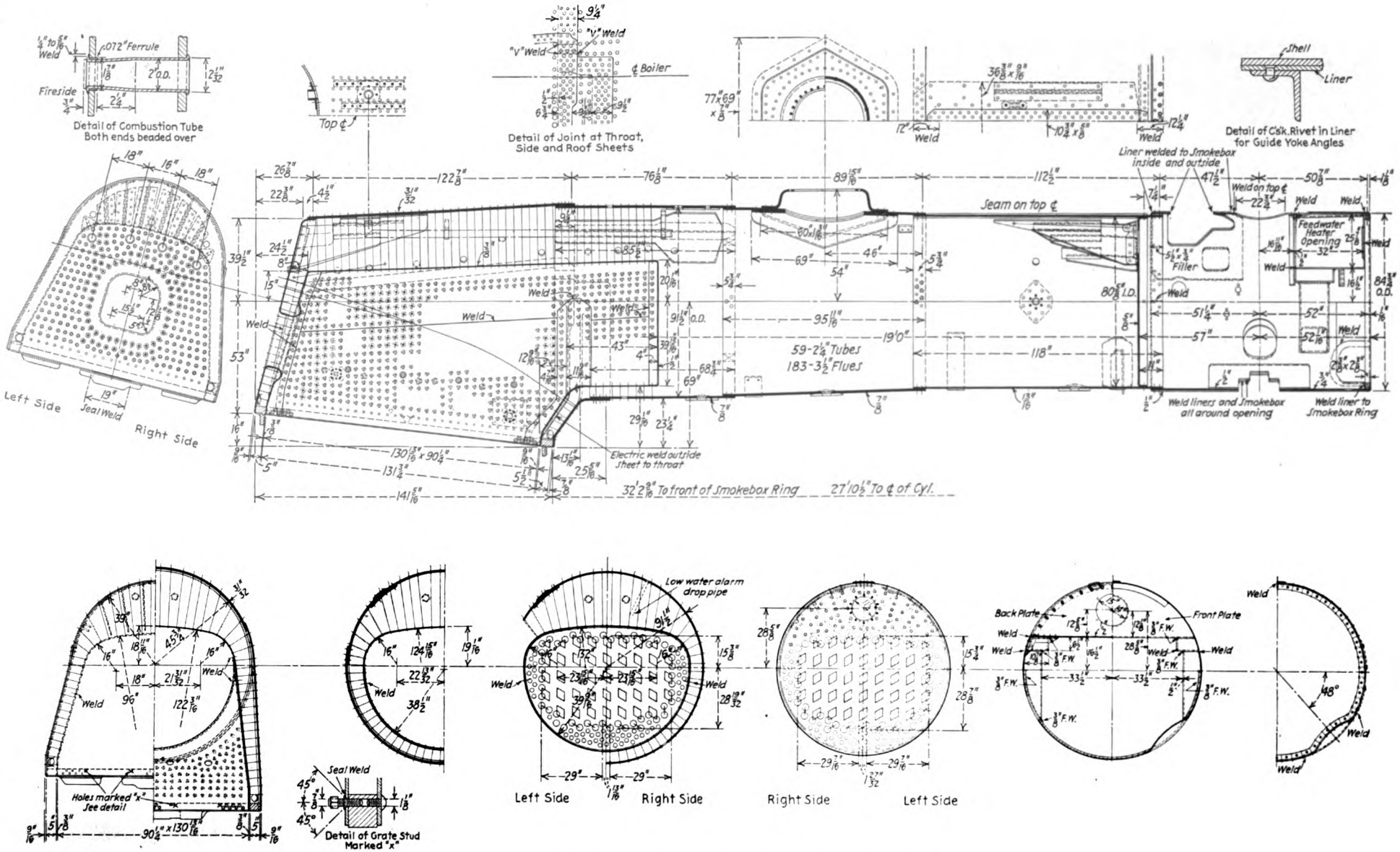
Interior of the cab of one of the streamline locomotives

Engine Bed and Running Gear

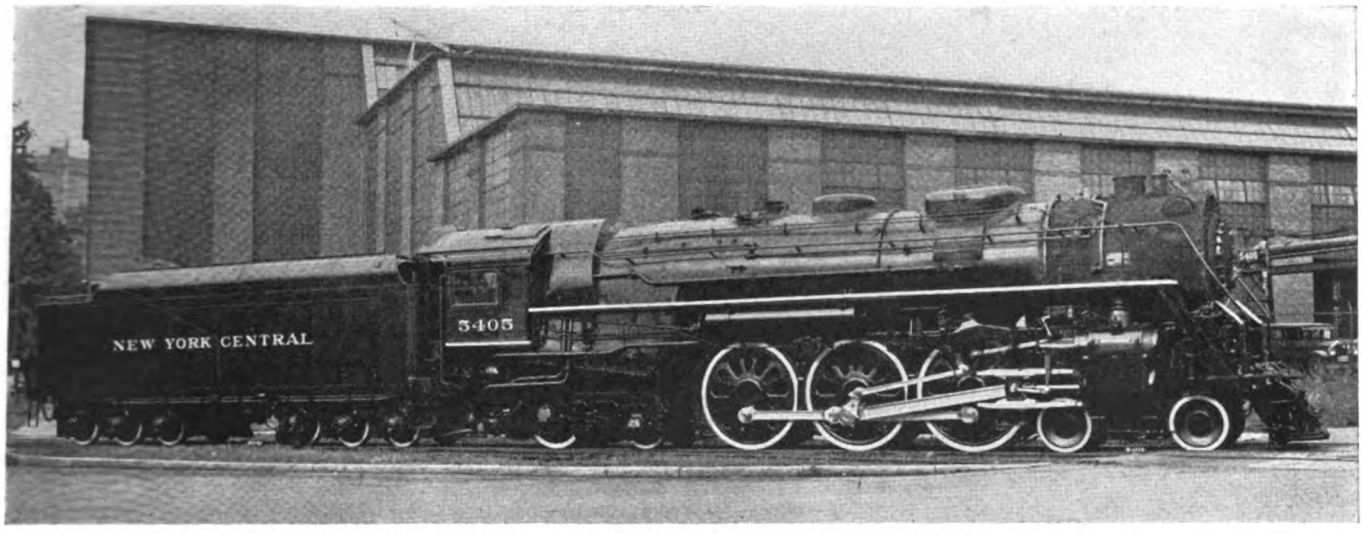
The foundation of the locomotive is the General Steel Castings engine bed. Cast integral with the bed are the cylinders and back cylinder heads, the brackets for the air compressors, the guide yoke, the valve-gear-frame cross-tie, pads for the driver-brake cylinders and reverse



The tender truck



Cross-sections and elevation of the boiler of the New York Central Class J-3a 4-6-4 Type Locomotives



gear, and attachments for the stoker engine and cab brackets. The front bumper beam and the pilot are separate steel castings. The pilot includes a pocket for the counterbalanced disappearing coupler.

The boiler is supported by sliding shoes at the front corners of the mud ring and by expansion plates below the back head. Waist sheets are located at the guide yoke, at the valve-motion support, and between the second and third pairs of drivers. The main reservoirs are of Cor-Ten steel and are mounted in Economy combination reservoir and pipe brackets, supported from the boiler. The running boards are supported on separate brackets attached directly to the boiler shell.

The driving wheels are of the General Steel Castings Boxpok type on 25 locomotives and the Scullin disc type on the remaining 25. They are mounted on normalized carbon-vanadium steel axles, hollow-bored to 3½ in. diameter. The driving-journal bearings are fitted with Timken roller bearings in single-piece housings. The pedestal faces in the bed casting are parallel and are provided with cast-steel shoes faced with rolled-bronze liners welded in place. The pedestal caps are of alloy steel. The driving springs have reverse camber with conventional equalization.

The four-wheel engine trucks are of the Commonwealth equalized type with inside journal bearings. The truck frame is of special design to permit the carrying of the brake cylinder under the bolster in a sleeve which is an integral part of the frame. The Timken roller bearings are mounted in one-piece housings.

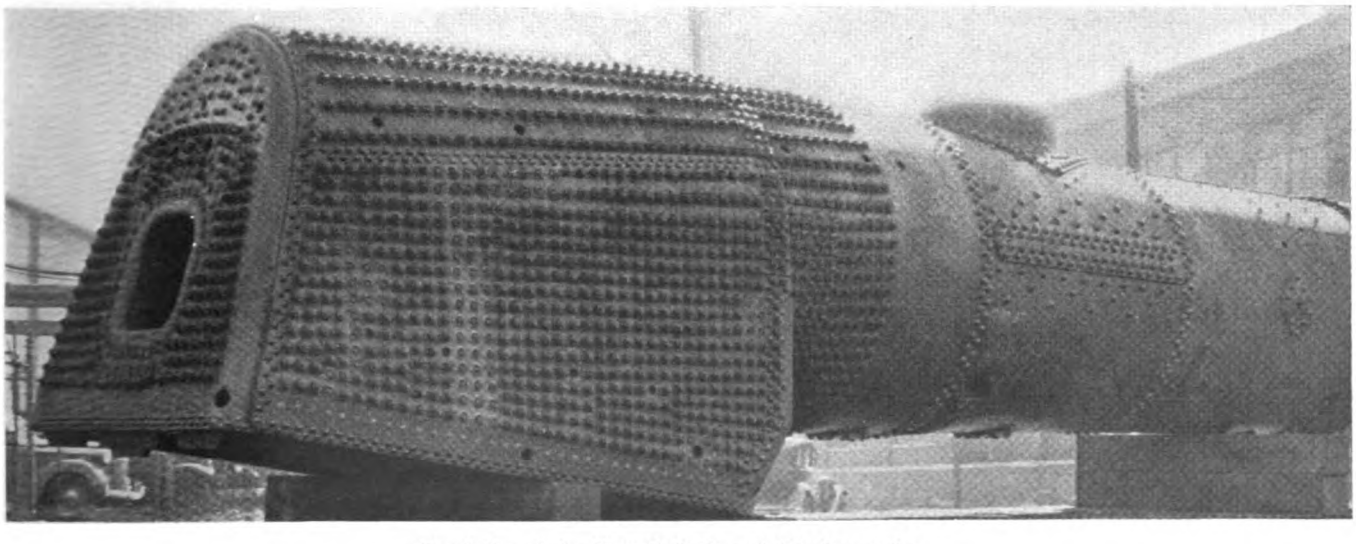
The trailer trucks are of the Commonwealth four-wheel type with outside journals which are fitted with Timken roller-bearing boxes. The Timken lateral-motion device is applied on the front trailer boxes. A Franklin C-2 type booster is installed on the trailer, the exhaust from which is discharged through the tank to the atmosphere.

The engine truck and front trailer wheels are rolled steel, while the rear trailer wheels have steel-tired cast-steel centers. Engine-truck axles are normalized carbon-vanadium steel, while the trailing truck axles are carbon steel. The rear trailer axle and engine-truck axles are hollow bored. All Timken bearings are equipped with automatic heat indicators. All pin bearings in the engine and trailer trucks, as well as in the spring rigging, are fitted with Ex-Cell-O steel bushings.

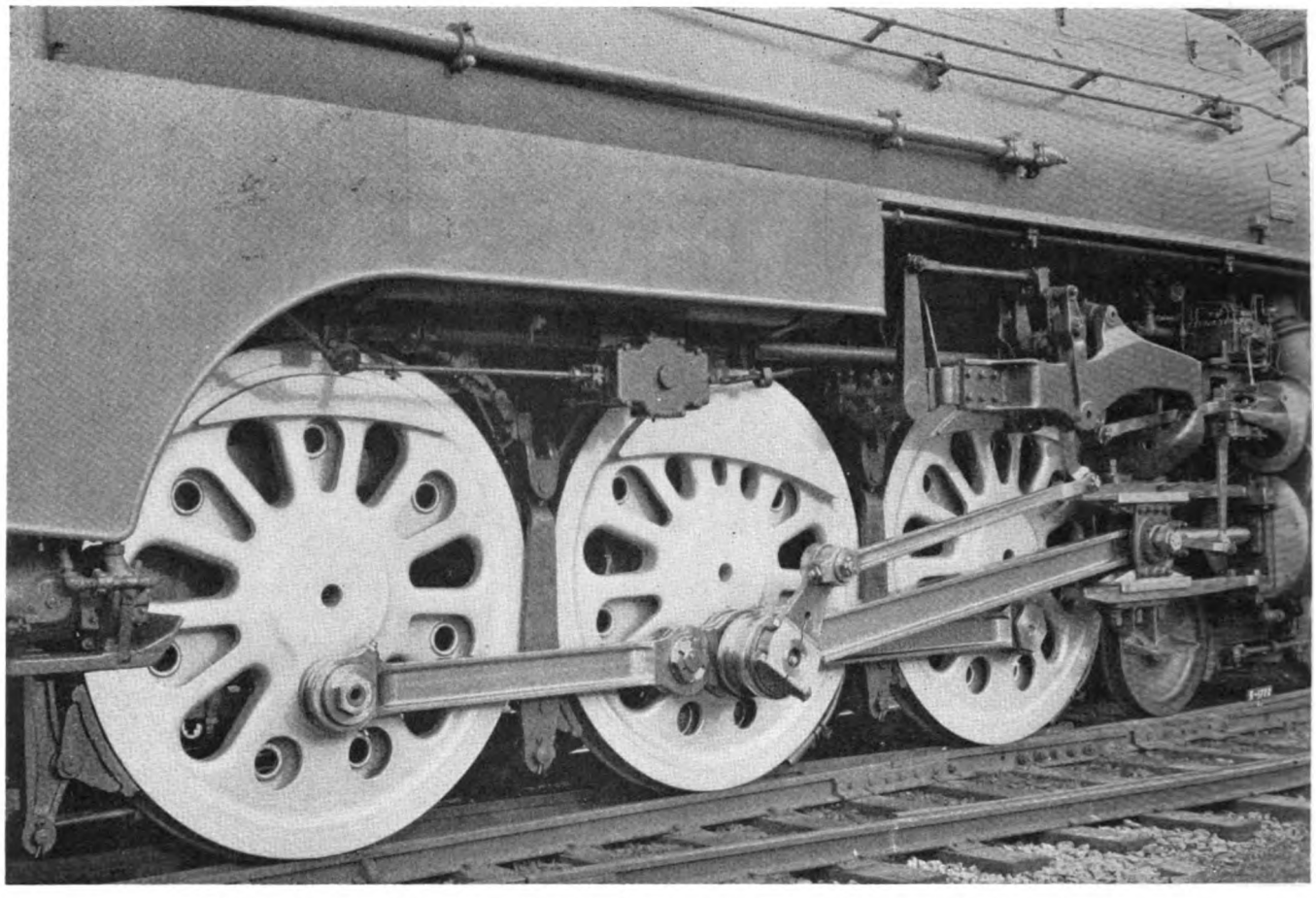
Driving Gear and Motion Work

The rods and crank pins on 45 of the locomotives are conventional. On five of the streamline locomotives are complete installations of Timken roller-bearing rods and crank pins. On all of the locomotives, however, the pistons, piston rods, and crossheads, including the wrist pins, are of Timken design and special alloy steel.

By the use of these parts the total weight of reciprocating parts on each side of the locomotive has been



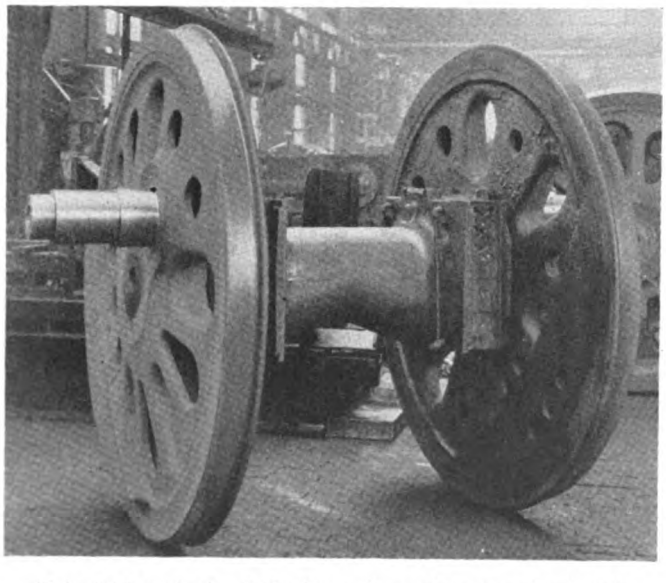
The boiler of the New York Central J-3a locomotive



The running gear of the locomotives equipped with plain-bearing rods and Boxpok driving wheels

reduced to 1,000 lb. and the dynamic augment decreased by about 50 per cent of that of the J-1 class. With an overbalance of 134 lb. in the front and back driving wheels and 100 lb. in the main driving wheels the calculated dynamic augment at 90 m.p.h. is 8,100 lb. in each of the front and back wheels and 6,020 lb. in each of the main wheels. The revolving weights are cross-counterbalanced in all wheels.

The guides are of the two-bar type with the Slid-Guide floating connection of the top guide at the cylinder head. The Timken-two-piece crosshead, with a draw fit on tapered circumferential shoulders of the piston rod, has forged shoes of aluminum alloy. The crosshead contains a roller-bearing wrist-pin assembly.



Main driving wheels of the locomotives with conventional rods

The main and side rods on 45 locomotives are of nickel steel. In the back end of the main rod and side-rod middle connection are three-piece bronze floating bushings with fixed bushings of Hunt-Spiller gun iron. The front and back side-rod bearings are bronze bushings, pressed in.

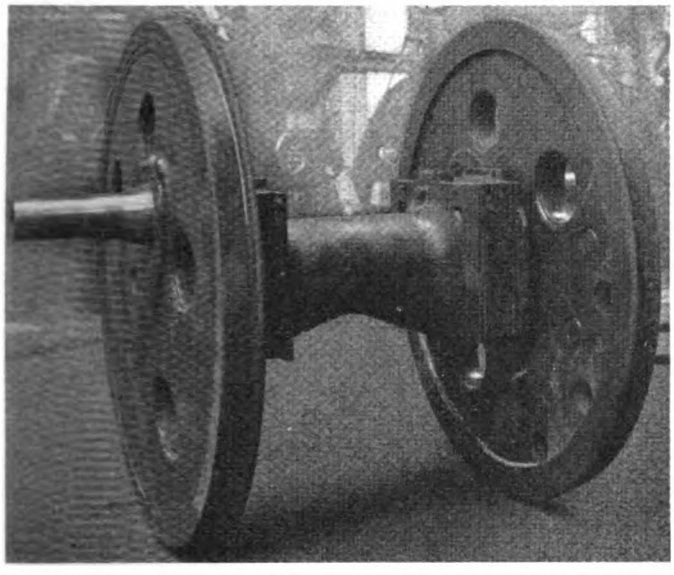
On the 45 locomotives with plain crank-pin bearings the main crank pins are of normalized carbon-vanadium steel and the front and back crank pins are normalized and drawn carbon steel. The main pins are hollow bored to a diameter of 4 in.; the others, to 2½ in.

The cylinders and valve chambers are bushed with Hunt-Spiller gun iron. The pistons are fitted with L. F. M. bronze lip and ring cylinder packing, while the valves have Hunt-Spiller gun-iron bull rings and snap packing rings. King type rod packing is applied on piston rods and valve stems.

All of the locomotives have Baker valve gears and Loco Valve Pilots. On the five streamline locomotives on which the Timken roller-bearing rods are installed Multirol needle bearings have also been applied in the valve motion.

The Franklin Precision type reverse gear is mounted on the engine bed on the longitudinal center line of the locomotive. By the use of spiral gear boxes and universal and spline slip joints the operating shaft is carried from the cab along the side of the firebox to the reverse-gear cylinder under the boiler with complete flexibility of adjustment to changing length due to the expansion and contraction of the boiler. The boiler mounting of the reverse-gear cylinder is particularly difficult to maintain satisfactorily because of the constantly changing thrust reactions to which the boiler studs are

subjected when the locomotive is in service. The engine bed provides a better anchorage and relieves the boiler of these stresses. Furthermore, the location of the reverse gear on the longitudinal center line of the locomotive, so that the connection to the reverse shaft is at a point midway between the two valve gears, equalizes any distortion of valve events which may be caused by torsional strains in the shaft.



Main driving wheels of the locomotives fitted with Timken roller-bearing rods

Lubrication

A force-feed lubricator is installed on each of the locomotives. Four feeds lead to the cylinders and valves, two to the guides, one to the air compressors and one to the stoker engine. The Nathan Type DV 24-pint lubricator is on half of the order and the Detroit 32-pint lubricator on the other half. The Nathan atomizers are used on all of the locomotives.

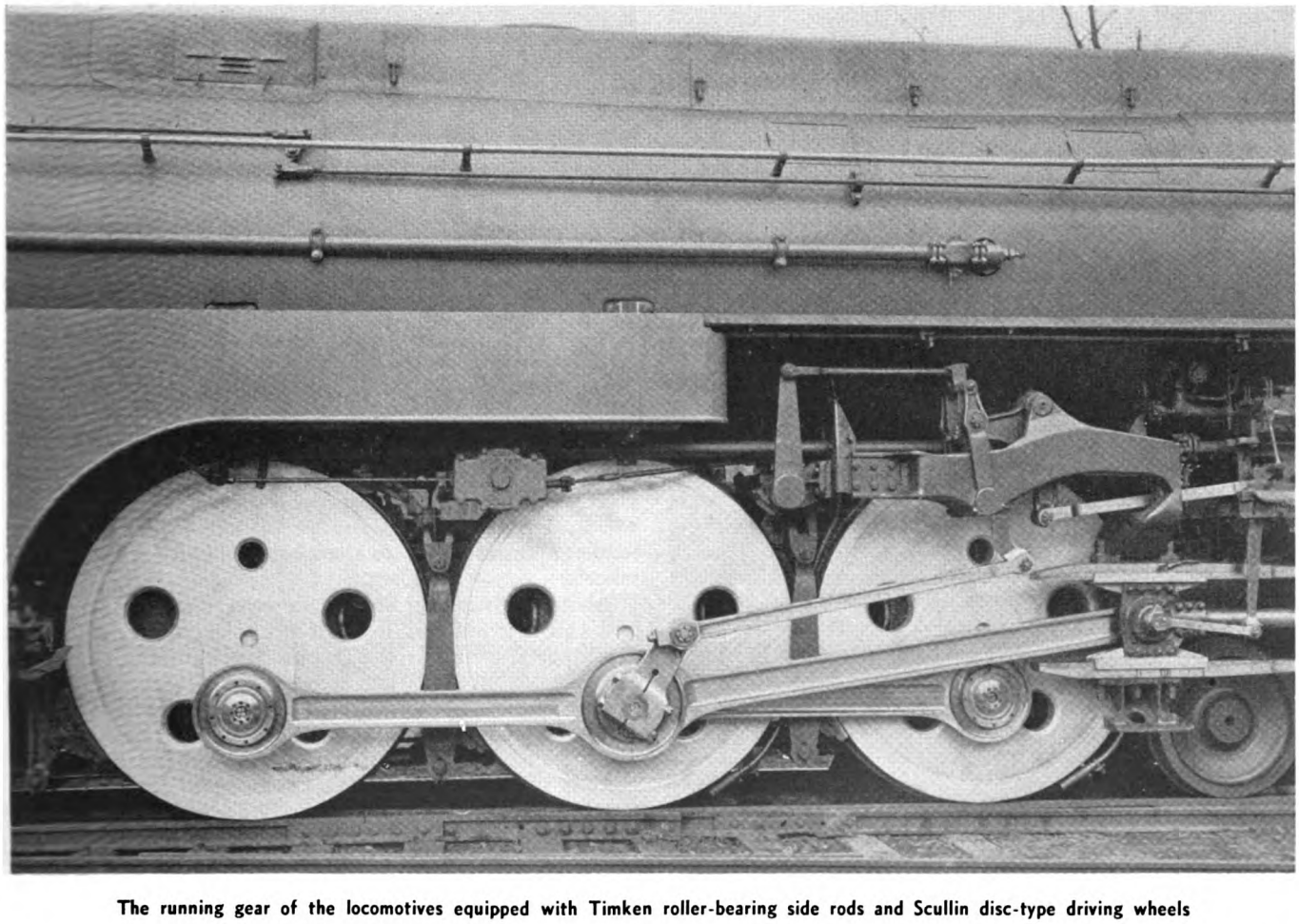
Alemite soft grease fittings are extensively applied. They are used on the valve gear, on the radial buffer, on the reverse gear, on the main and side rods, on the valve-stem crossheads, on the trailer spring-hanger pins, on the water-scoop piston rod, and on such auxiliaries as the Elesco feedwater pump and the speed recorder connections.

Rexoil fittings are installed for engine-truck-box, driving-box and trailer-truck-box pedestal lubrication and for roller-bearing wrist-pin lubrication. They are also applied on the roller-bearing rods.

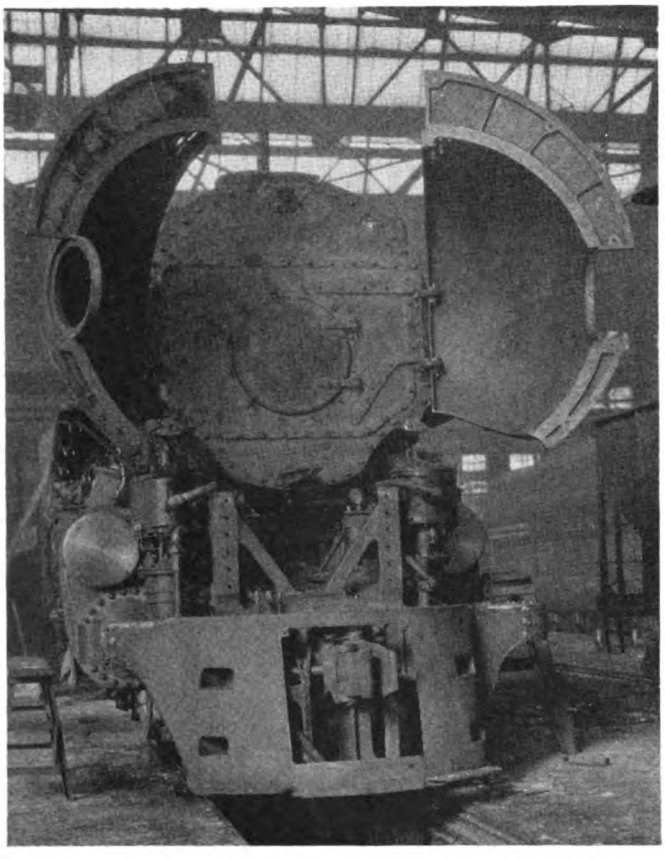
On all of the locomotives equipped with plain-bearing rods and crank pins there are air connections for use with a portable pneumatic grease gun with which the rods are lubricated.

The Cab

Aluminum alloy has been used extensively on these locomotives. The cabs and running boards of all but 10 of the non-streamline locomotives were built of this material, while Cor-Ten steel was used in the construction of the cabs and running boards of the remaining locomotives. The cabs and running boards of the 10 streamline locomotives are also of aluminum alloy, as are the cylinder and valve-chamber casings on all loco-



The running gear of the locomotives equipped with Timken roller-bearing side rods and Scullin disc-type driving wheels



The streamline nose is divided and hinged to facilitate access to the smokebox

tives. The hand rails are of aluminum pipe. Aluminum is also used for dome casing, safety-valve and steam-turret casings, and cab gage board. Laminated type safety glass is used in the cab windows and windshields.

The No. 8ET brake equipment was furnished by the New York Air Brake Company. The brake is modified to include the electro-pneumatic and speed-governor control for use with cars equipped with the H. S. C. type brakes. The brake valve is pedestal mounted.

Brake shoes are applied on the engine truck and the rear pair of trailer wheels as well as on the drivers. The braking ratio on the drivers and engine truck is 60 per cent and on the trailer 45 per cent.

The locomotives are fitted with the General Railway Signal train control. Graham-White sanders are applied. The sand capacity is 27 cu. ft.

The Tender

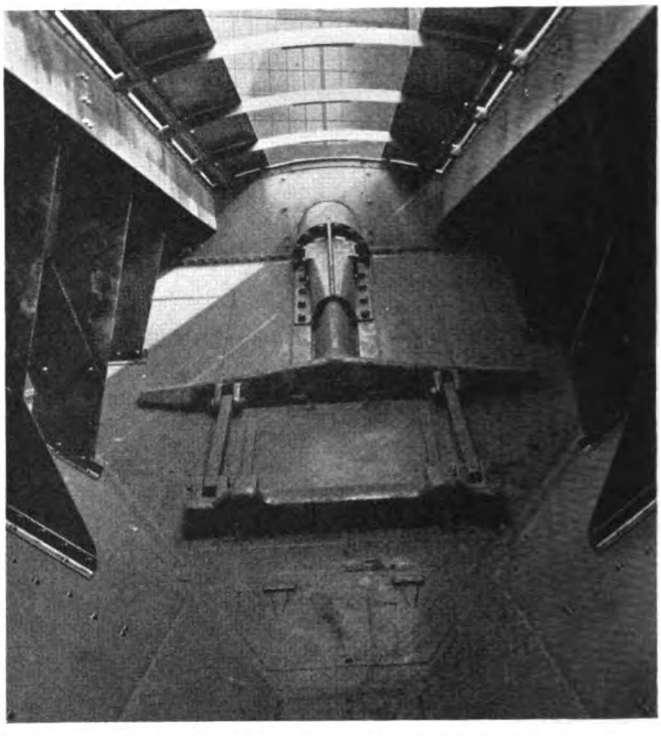
The tender tank is built up on a Commonwealth water-bottom cast-steel underframe. The water capacity is 14,000 gallons and the large coal space carries 30 tons. The tenders are fitted with water scoops and coal pushers are installed.

The tender trucks are of the Commonwealth six-wheel type with rolled-steel wheels. The tender axles are fitted with SKF roller-bearing boxes. Clasp brakes are applied on the trucks, with body-mounted cylinders.

All air and steam lines have Barco flexible connections between the engine and tender. The Vapor flexible metallic steam-heat connection is applied at the rear end of the tender. The tender drawbar is equipped with the Waugh rubber draft gear. The streamline locomotive tenders are equipped with A. A. R. tight lock couplers, furnished by the National Malleable and Steel Castings Company.

The Streamline Locomotives

The streamline locomotives are finished to the design of Henry Dreyfuss, offer relatively little interference to access to running gear and motion work, and weigh only 5,500 lb. more than the conventional design. The streamlining consists of the lagging and jacketing of the smokebox with a bullet nose type of covering over the front end and a housing over the top of the boiler extending forward from the cab to include the smoke stack, with air openings at the front for smoke-lifting purposes. The headlight is located at the middle of an aluminum crest which follows the contour of the bullet nose along the vertical center line of the locomotive from the housing which covers the top of the boiler to the shrouding which covers the space under the smokebox. This shrouding also covers the pilot. At the sides it extends only as far as the steps from the bumper beam to the running board. Below the running board, beginning at a point approximately half way back, is an apron which con-



Hinged hatches partially covering the coal space on the streamline locomotives are operated from the front of the tender

forms roughly to the line of the throat and mud ring and extends back to the rear of the cab.

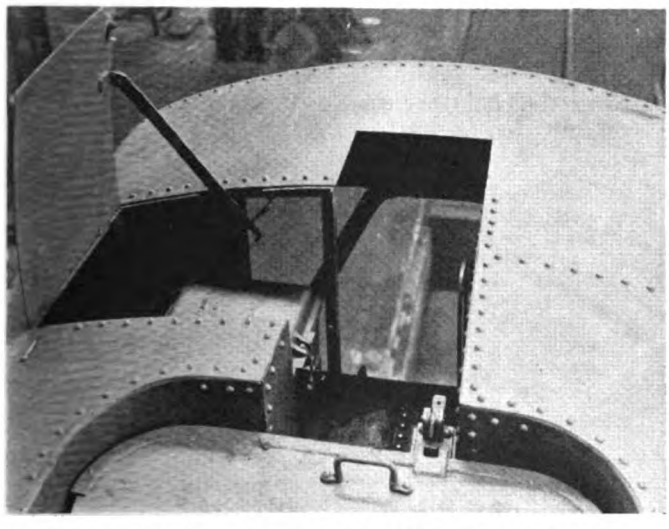
A housing which covers the sides of the tender coal space conforms to the curve of the cab roof. An inwardly curving skirt is dropped below each side of the tender approximately to the centers of the tender-truck wheels.

Above the running boards the boiler jacket, shrouding and cab are finished in light gray Duco. The underneath parts, including the frames, trucks and other parts, are finished in a darker tone of gray with aluminum finish on the driving wheels. The front cylinder head and valve-chamber casings are in the natural aluminum color. The main and side rods, as well as the valve-motion rods, are polished. Lettering and the striping on the tender are in aluminum. There are two longitudinal stripes in blue on the sides of the tender, one above and one below the aluminum striping and lettering. The background of the emblem on the front shrouding is also in blue.

There are relatively few changes in the location of equipment about the locomotive as a result of the streamlining. The Pyle-National turbo generator has been moved from the top of the boiler to a bracket on the engine bed just ahead of the trailer truck on the right side, opposite the location of the feedwater pump. The bell has also been removed from the top of the boiler and placed under the pilot.

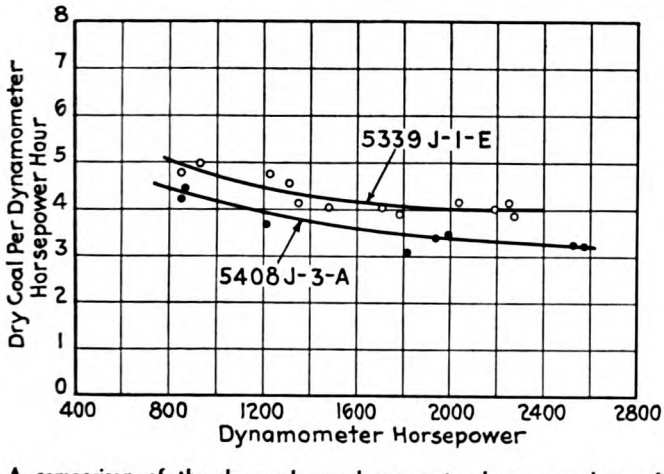
Test Performance

In dynamometer tests the new J-3a locomotives have developed a boiler capacity approximately 10 per cent greater than that of the J-1 locomotives, with an accompanying increase in boiler efficiency of about the same value. They have developed a maximum indicated horsepower of 4,700 at 80 m. p. h. and a maximum drawbar horsepower of 3,880 at 65 m. p. h. The J-1 locomotives in a number of tests developed a maximum indicated horsepower of 3,950 at 65 m. p. h. and a maximum drawbar horsepower of 3,200 at 57½ m. p. h. This is an increase in drawbar capacity of the J-3 over the J-1 of 21 per cent.

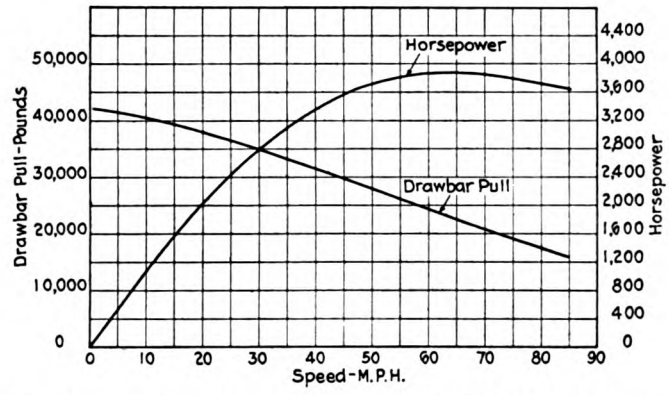


Hatchway leading from the rear of the tank to the filling-hole cover on the streamline locomotives—The trap door opens over the train-control equipment

At medium-capacity performance, burning 5,500 lb. of dry coal, tests of the new locomotive show an equivalent evaporation of 63,000 lb. per hour which compares with an equivalent evaporation of 57,500 for the J-1 locomotives at the same coal rate. This is an increase from an equivalent evaporation of 10.5 lb. per pound of dry coal to 11.5 lb. per pound of dry coal, or 9.6 per cent. At the high combustion rate of 8,250 lb. of dry coal per hour the new locomotives produce an equivalent evaporation of 89,000 lb. as compared with 81,000 lb. for the earlier class. This is an increase in equivalent evaporation per pound of dry coal from 9.9 to 10.8, or 9.1 per cent. Although the boilers of the new locomotives have less superheating surface than those of the earlier class, largely because of the shorter tubes, they consistently show 30 and 40 deg. F. higher superheat at medium and high rates of boiler output, respectively.



A comparison of the dry coal per dynamometer horsepower-hour of the J-1e and J-3a classes of the New York Central



Drawbar pull and drawbar horsepower characteristics of the J-3a class 4-6-4 type locomotives

In the range of average dynamometer horsepower (from 2,000 to 2,300) the new locomotives develop a drawbar horsepower with from 3.4 lb. of dry coal at 2,000 hp. to 3.25 lb. of dry coal at 2,300 hp. The locomotives of the earlier design showed approximately a flat dry coal rate of 4 lb. throughout this horsepower range.



Rear of the streamline tender

Service Failures

By Fred H. Williams, M. Sc., F. R. S. A.

FOLLOWING the several articles on failures of locomotive parts, it may be profitable to check up on other types of equipment and study some of the smaller parts which frequently fail in service. We are all familiar with the old hand car which was modernized and equipped with a gasoline motor, the drive being through a crank shaft. Photographs of one of these broken shafts are shown in Fig. 1. The view at the left gives a good idea of the design of the shaft and the location of the fracture. The other end of the shaft, showing the section through the break, is at the right, an enlarged view of this break being shown in Fig. 2.

The nucleus of the fatigue crack is at the surface, on the inside of the crank arm, and is just at the root of a sharp corner, where the face of the arm was machined off for clearance. The photograph does not bring out this detail as clearly as it should and the small sketch has been added to give a better conception of the actual condition. Instead of leaving a nice fillet, the tool cut a square corner, and not too smoothly at that. The machinist, apparently thinking that the corner was about 3/8 in. from the real fillet—and being on the side—it did not matter whether a fillet or a square corner was made. The result was that the shaft not only cracked, but actually broke in service. Obviously it does not require a great amount of expense to replace such a shaft, but a failure in service involves the possibility of the workers on the car being stranded at some out-of-the-way place, involving all sorts of inconveniences and possible expense.

As in the case of the failures of locomotive parts which we have studied, the surfaces were subjected to alternating or reversible stresses. The first breakages of these crank shafts occurred when the fillet between the pin and the arm was quite sharp. This was remedied, but unfortunately, in taking another cut to provide proper clearance for the arm, a sharp corner was left—and with disastrous results. It should be emphasized, also, that the fillets should be smooth and polished and be entirely free of score marks and tool marks.

A more recent model of one of these crank shafts which failed, is illustrated in Fig. 3. The side view shows the shape of the shaft and the location of the fracture; below it are views showing the fractured surfaces. Fig. 4, an enlargement of the surface of the machined section alongside the break, indicates clearly that the fracture followed lines left by rough machining of the fillet. This may have been due to speed in production, or to carelessness, or to a lack of appreciation of the importance of using great care in machining and finishing such surfaces. While it may be argued that the crank shaft on a remodeled hand car is not of very great importance, one can readily conceive of instances when a disabled hand car, at a critical time, may be of greatest importance. In railroad operation the strength of a chain is only as great as its weakest link.

Change in Diameter of the Shaft

A broken armature shaft of a car lighting generator which failed in service is shown in Fig. 5. One would think that only the best of materials and finishes, as well as the best design would be used for such services. This part, however, failed because of a square cut corner with no fillet when a reduction in section was made.

The extent of this may be judged by comparing the two broken parts in Fig. 5, or by referring to the cross section of the break shown in Fig. 6. The shaft broke in the sharp corner and there was the usual progressive crack, which we have come to know as a fatigue crack.

Frequently it is stated that a failure is caused by a flaw in the steel, whereas the real cause is a fatigue crack which developed progressively, until a blow or shock was greater than the remaining strength of the section and the part failed suddenly. It is true that there are cases where failures have been caused by impurities or defects in the steel, which caused fatigue cracks to start. Generally, in these cases, however, the crack starts within the section and not from the surface.

Fig. 1—Two photographic views showing fractured crank shaft of motor car. (The small sketch between these two views illustrates the conditions more clearly.) Fig. 2—Enlarged view of fracture of the crank shaft shown in Fig. 1. Fig. 3—Crank shaft that failed in service because of rough machining. Lower view shows fractured faces. Fig. 4—Enlarged view showing finish on the side of the crank arm (Fig. 3) which was machined for clearance. Fig. 5—Broken parts of car lighting generator armature shaft. Fig. 6—Enlarged view of fractured end of armature shaft shown in Fig. 5

The two parts in Fig. 5 are so placed in the photograph that the fractured ends are at the right, the fracture taking place where the sharp reduction in the section of the shaft occurred. It is quite apparent from the cross section in Fig. 6 that an attempt was made to form a fillet, but it was so small as to be useless and the machining was also quite rough. The frilled edges of the fracture indicate that the cause of the failure was tears in the surface of the metal. Many small cracks started, eventually joining up and making one well marked fatigue crack, which caused the failure. This type of failure is not infrequent and until the manufacturers and the railways realize the consequences of inadequate fillets and rough finish, failures will continue to occur, to the loss of the railways and the inconvenience of the traveling public.

A curious thing happened in attempting to improve conditions. A new lot of armature shafts was applied with fillets of generous proportions. The finish of the surface of the fillet, however, was filled with fine score marks, left by the use of emery cloth and a stick or some other instrument of torture. Closer examination showed that one mark was deeper than the rest. Questioning the man regarding the assembly and watching him put the parts together to replace in stock, I noticed that the lock washer was removed to reverse it in order to clamp the assembly. Examining this washer, I found that it was a cut washer, pressed concave or dished. When the assembled parts were held tightly by this dished washer, wrongly put in place, the sharp edge

(*Continued on page 181*)

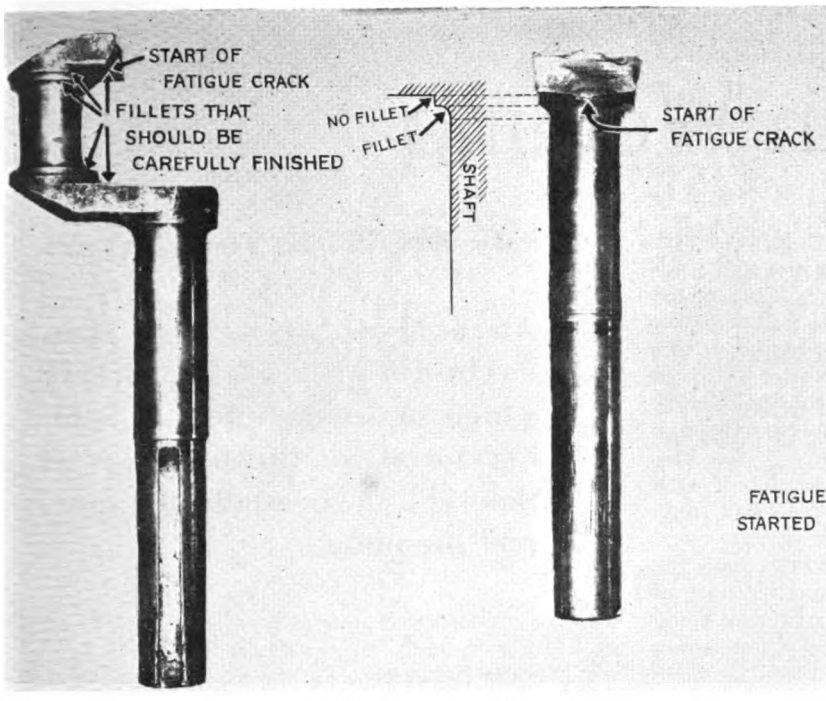


FIG. 1

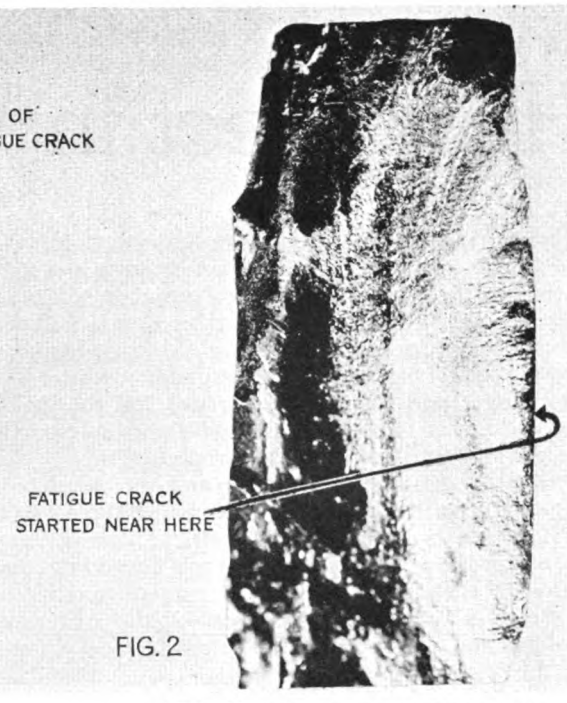


FIG. 2

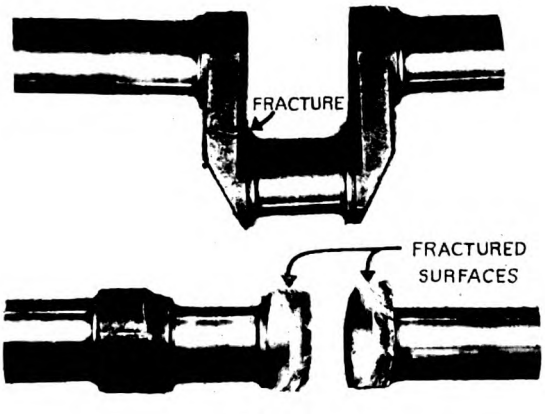


FIG. 3

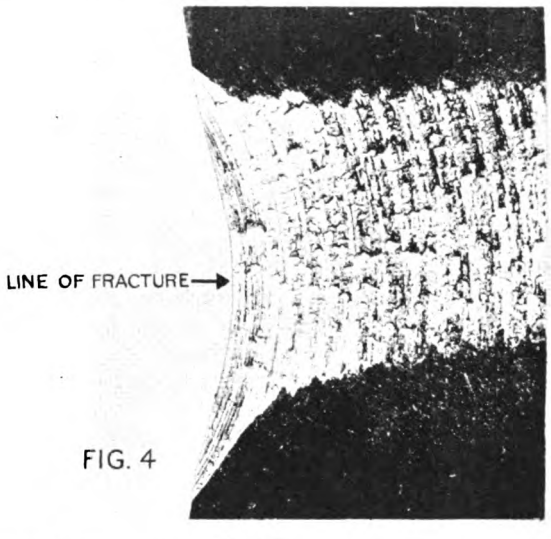


FIG. 4

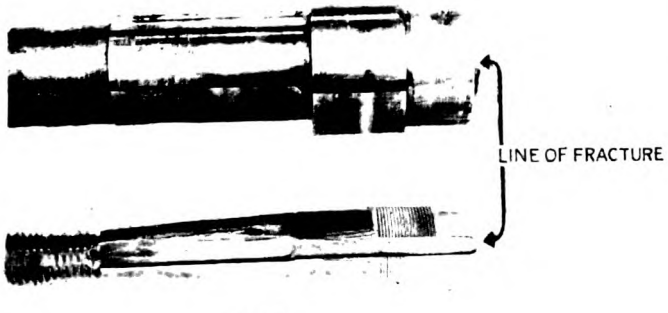


FIG. 5

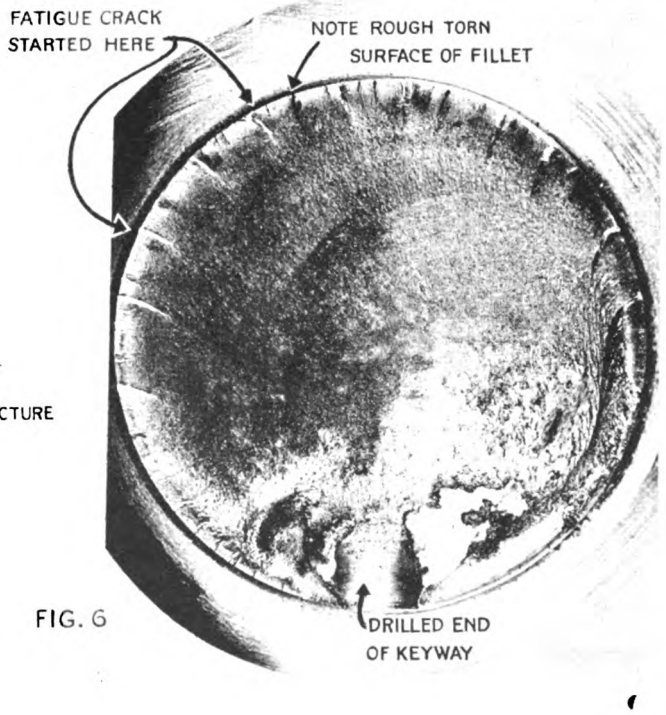


FIG. 6

An Analysis of

Heat Effect in Welding*

By Dr. W. G. Theisinger†

An analysis of welded plain carbon and low-alloy steels which shows the effect of welding speed on the hardness of the weld, the heat-affected zone, and the plate

THE commercial interest in the heat effect produced by welding is centered about the hardening in the metal adjacent to the weld, sometimes resulting in cracks in the parent steel. Regardless of whether or not failure to the point of rupture occurs near the weld, hardening in this region should be kept to a minimum in order to avoid the danger and cost of shop cracks and the inability to absorb impact in service, otherwise encountered through an area of unequal physical properties.

In order to study the cause and the development of these effects, it is necessary to consider the several functions of the welding process itself. These various operations produce results to a degree depending upon the value of each element, such as current and its time of application, mass and condition of the material being welded and, most important, the chemical composition of the material.

Welding makes use of the melting, casting, solidification and subsequent heat-treatment of metals in its application to fabrication processes. The electric arc or the oxy-acetylene flame heats the metal surfaces to the molten state and casts this liquid by the movement of the heating instrument. Solidification of the deposited metal results from its loss of heat by radiation into the surrounding atmosphere and by the conduction of its heat into the adjacent base metal. Heat treatment manifests itself in the parent member by virtue of this heating effect created by the fused metal and the heating medium. Even though the procedure employed by welding in transforming a solid metal to the fluid state and back again to solid form in the space of a few seconds or fraction of a second takes place more rapidly than is customary in heat-treating practices, the mechanics of the physical changes are, as a matter of fact, metallurgical in nature.

The heat-affected zone found in welded sections is due to the property possessed by iron, containing a sufficient amount of carbon, of becoming extremely hard when rapidly cooled from a high temperature, as for instance, by quenching in water from a bright red heat. This operation is known as the hardening of steel. In order to harden steel, it is necessary first to heat it above its critical range because it is in passing through that range that it acquires hardening power. Sudden cooling from a temperature inferior to its critical range would result in but a very slight, if any, increase in hardness.

The requirements for hardening the parent steel plate in the heat-affected zone adjacent to a weld are satisfied in every detail. The steels studied in this investigation contain not less than 0.15 per cent carbon so that rapid quenching would produce a measureable increase in hardness. Rapid quenching is brought about in welding by the mass action of the parent metal in conducting the heat rapidly away from the vicinity of the weld.

Temperatures far exceeding the normal heat-treating critical range are reached in melting the metal, and the amount of steel melted in making a weld is small in comparison with the size of the parent member. In addition, the heat gradient is steep from the fused area to that portion of the plate which remains at a temperature below the critical range. For this reason, the heat-affected or hardened zone is usually limited to a fraction of an inch in depth beyond the weld.

Thus the heat-affected zone is found in any process which produces a weld. Its depth and hardness depend upon the variables present. It is apparent that this zone of unequal hardness which disrupts the continuity of the physical properties should be eliminated or at least kept to a minimum.

The heat effect becomes visible on a cross section of

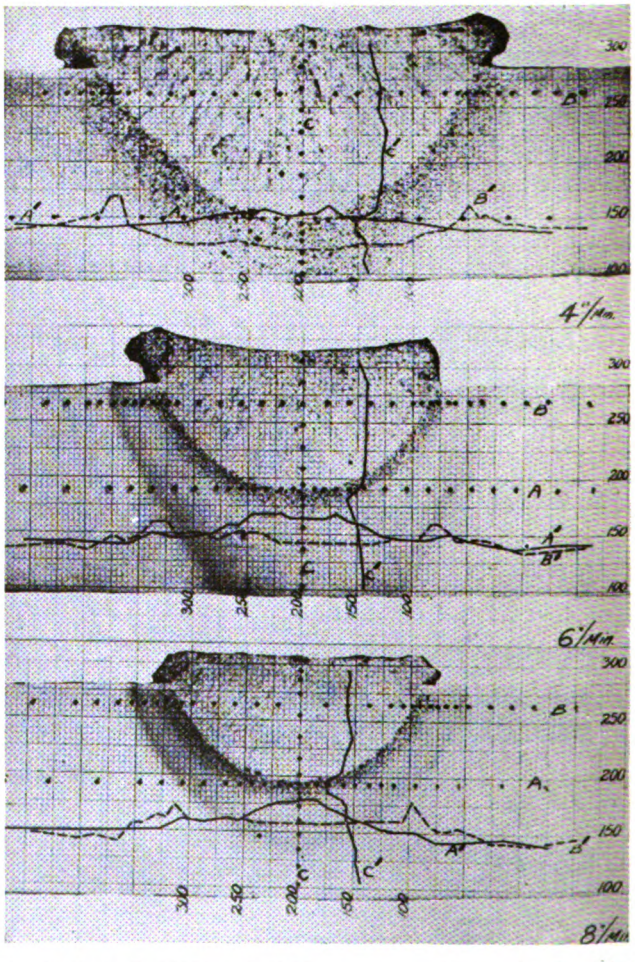


Fig. 1—S. A. E. 1035 steel (0.33 per cent carbon) x 4. Top: Hard zone = Vickers-Brinell using a welding speed of 4 in. per min.—Center: Hard zone = 168 Vickers-Brinell, using a welding speed of 6 in. per min.—Bottom: Hard zone = 177 Vickers-Brinell, using a welding speed of 8 in. per min.

* Presented at the twenty-fourth annual meeting of the Master Boiler Makers' Association, held at Chicago, September 28-30, 1937.

† Welding and Metallurgical Engineer, Lukens Steel Company, Coatesville, Pa.

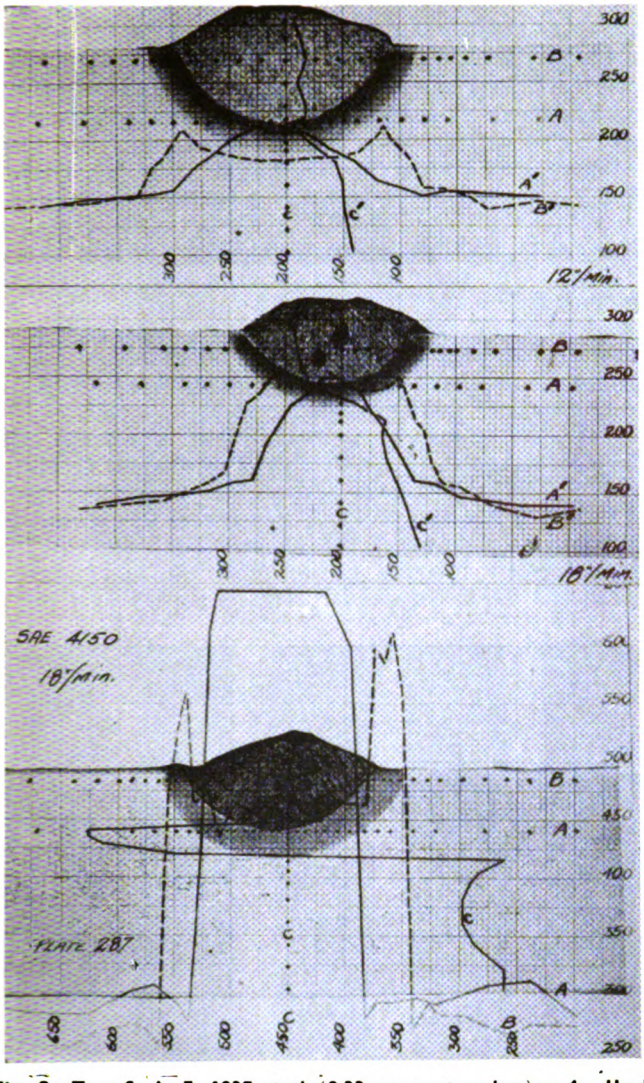


Fig. 2—Top: S. A. E. 1035 steel (0.33 per cent carbon) x 4. Hard zone = 212 Vickers-Brinell, using a welding speed of 12 in. per min. Center—S. A. E. 1035 steel x 4. Hard zone = 250 Vickers-Brinell, using a welding speed of 18 in. per min.—Bottom: S. A. E. 4150 steel (0.52 per cent carbon, Cr — Mo) x 4. Hard zone = 642 Vickers-Brinell, using a welding speed of 18 in. per min.

the welded specimen after suitable etching of the polished surface. It appears as a zone of varying shades of color grading from black to light gray in the plate material at the rim of that portion of the weld which is in contact with the parent member.

It has been pointed out that the welding process brings about the conditions which cause the hardening in the heat-affected zone adjacent to the weld. This would imply that amperage is the greatest contributing factor, yet the heat energy input per unit of weld is of greater importance, thus introducing speed of welding as one of the main variables. The higher the welding speed, the more rapid is the quench and the greater is the hardness.

However, there are other variables outside the welding process itself which exert considerable influence. For example, all other conditions being equal, a thick plate will produce a greater hardness than a thin plate.

The most powerful variable affecting the hardness of the plate metal adjacent to a weld is the hardening power of the plate metal. The common method of raising the hardening power of ferrous metals is to increase their carbon content. Carbon increases the tensile strength, but it also augments the response of the steel to hardening operations. The low-alloy steels attain the higher physical values by the use of alloying elements other than carbon.

The variables of paramount importance which govern the extent of the heat affected zone in arc welding are (1) base-metal composition, (2) speed of welding, (3) heat-energy input, and (4) base-metal cross-section.

In this study, the welded specimens were prepared by depositing the "weld," or in more exact terms, a "bead" on the top surface of a series of steels ranging from 0.17

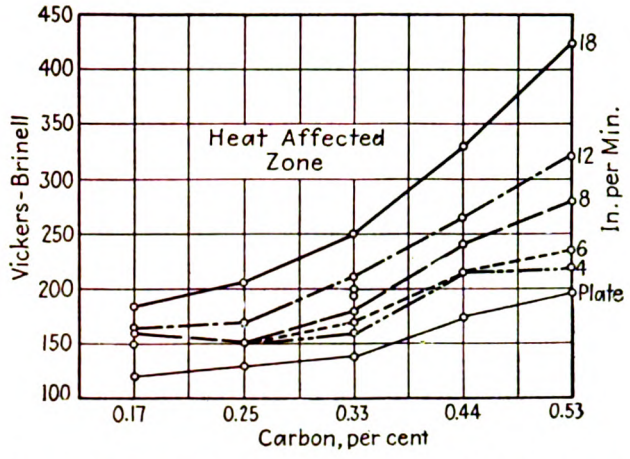


Fig. 3—Summary of hardness values on five plain carbon steels welded at varying speeds. The hardness of the unaffected plate is shown for comparison

to 0.53 per cent carbon, using an automatic welding machine and bare wire. With no alloying elements being added intentionally, these steels are classed as plain carbon steels. Vickers-Brinell hardness impressions were run across the weld, affected zones, and the plate metal beyond the weld, and photomicrographs were taken to reveal the structure in the affected region.

The hardest portion of the heat-affected zone is immediately adjacent to the weld, as may be seen by the accompanying illustrations, and the real measurable increase in hardness usually does not extend over ¼ in. beyond the weld into the plate. This is indicative of the steep temperature gradient, which exists in this area. As a matter of fact, in this confined zone, the temperature must range from 1,530 deg. C. (the melting point of steel) at the weld to 700 deg. C. at the outer edge of the heat zone, beyond which there is no change in microstructure. Hardness curves for an S. A. E. 1035 steel of 0.33 per cent carbon is shown in Figs. 1 and 2 for welding speeds of 4, 6, 8, 12 and 18 in. per min. The amperage and voltage values are held constant, and the plate dimensions of 9 in. × 2 in. × ½ in. are maintained throughout. The cross sections were taken at right angles to the direction of welding and were polished and etched to reveal the weld and the plate metal. The heat-affected zones appear in the base metal adjacent to the weld. The area of this zone decreases with increasing welding speed, but the hardness increases as the welding speed becomes greater. In other words, the slower welding speeds produce a greater spread of heat through the adjacent metal

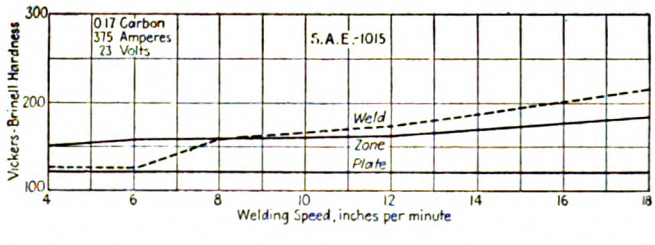


Fig. 4—Hardness curves for S. A. E. 1015 steel (0.17 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 18 in. per min.

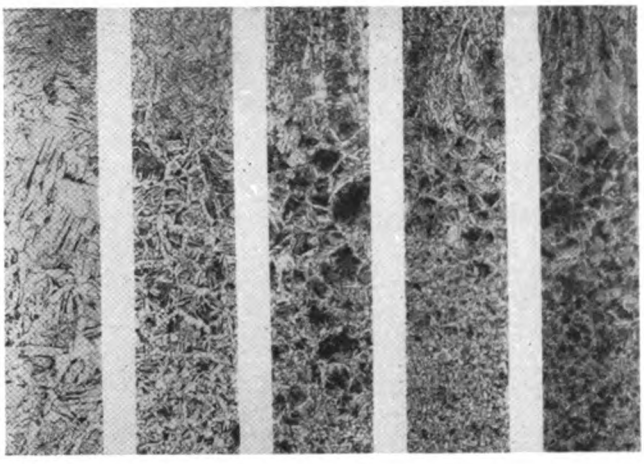


Fig. 5—S. A. E. 1015 steel (0.17 per cent carbon) etched with 1 per cent Nital x 150. Left to right these views show microstructures for welding speeds of 4, 6, 8, 12 and 18 in. per min. and show pearlite to sorbite with decreasing grain structure. Fine grain structure at the extreme top of each view is the weld area while the coarse grain structure is the plate area

and thus slows down the quenching rate action of the base metal on the heated region surrounding the weld.

Three lines of hardness impressions extend across the face of the specimen, one vertical and two horizontal lines. The hardness curves are superimposed on the macrographs of the welded specimens and may be referred to for the hardness of any particular point.

The solid curve A' indicates the hardness of the horizontal line A of impressions tangent to the base of the weld. The broken curve B' shows the hardness of the horizontal line B near the top of the specimen. The solid line C' follows the vertical C through the middle of the weld and heat zones. The extremes of the curves reveal the hardness of the unaffected base metal, although this actual determination was made near the sides of the specimen, beyond these views.

The peaks of the hardness curves coincide with the plate metal adjacent to the weld wherever a line of impressions crosses this area. These peaks become more pronounced naturally as the speed of welding is increased. The slower welding speeds result in a more uniform distribution of physical properties across the region.

Hardness curves are also shown in Fig. 2 for an alloy steel of 0.52 per cent carbon; the steel is S. A. E. 4150, and is included here as an example of an extremely high hardness that may be found in a steel of high hardening power welded at high speed. The microstructure in the plate metal adjacent to this weld is completely martensitic as is to be expected from a hardness of 642 Vickers-Brinell. After stress relieving at 1,150 to 1,200 deg. F. the hardness of this specimen was reduced to 370 Vickers-Brinell.

The hardness results obtained from the exploration of the plain carbon steels ranging from 0.17 to 0.53 per cent carbon are summarized in Fig. 3. The Vickers-Brinell

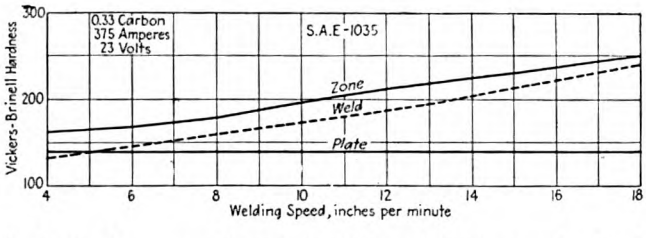


Fig. 6—Hardness curves for S. A. E. 1035 steel (0.33 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 16½ in. per min.

values are shown with carbon content and the curves are plotted for each welding speed. The lower-carbon steels may be welded at even the fastest rate without provoking objectionable hardening in the affected area, whereas the higher-carbon steels are not as foolproof and must be given more consideration in the selection of a welding speed. If a line were drawn at a random figure of 225 Brinell, then the 0.17 and 0.25 per cent carbon steels may be welded at 18 in. per min., the 0.33 per cent carbon steel at 12 in. per min., and the 0.44 and 0.53 per cent carbon steels limited to 6 in. per min. This simply points out that as the carbon content of the plate metal is increased, the welding speed should be decreased. Figs. 1, 2 and 3 are given in general terms to be considered as trends and not as specific requirements.

The significant fact suggested by Fig. 3 is the peculiar position occupied by the 0.33 per cent carbon specimen. As the carbon increases beyond this point, the curves rise rapidly for any welding speed, and the spread between the hardness of the affected zone and the unaffected plate becomes greater with the higher-carbon steels and the faster speeds. This is further evidence of

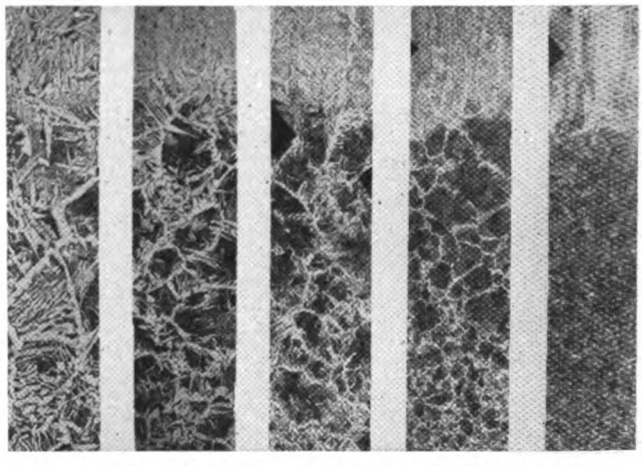


Fig. 7—S. A. E. 1035 steel (0.33 per cent carbon) etched with 1 per cent Nital x 150. Left to right these views show microstructures for welding speed of 4, 6, 8, 12 and 18 in. per min. and shows pearlite to sorbite with decreasing grain structure. Fine grain structure at the top of each view is the weld area while the coarse grain structure is the plate area

the hardening power which carbon imparts to steel and its susceptibility to any hardening operations. Up to 0.33 per cent carbon, the rise in hardness of the steel is gradual.

In Fig. 4, the hardness curve of S. A. E. 1015 (0.17 per cent carbon) steel is shown. The maximum variation from the unaffected plate is only 65 points Brinell, i.e., from 120 to 185 at 18 in. per minute. Such a steel may be welded in the medium gages without much concern for the heat-affected zone and the hardness resulting from the welding operation.

The microstructure of a portion of the weld and much of the heat-affected zone is shown in Fig. 5 for the five welding speeds corresponding to those given in Fig. 4. The large grain structure appearing in the 4-in. speed sample is to be expected from the slow cooling rate such a welding speed imparts to the steel. This structure is made up of pearlite and sorbite with decreasing grain size as the more rapid cooling rates are met with in the higher welding speeds.

An S. A. E. 1035 (0.33 per cent carbon) steel was selected from the group for illustration; the hardness curves of this steel are shown in Fig 6. This chart is a summary of the curves for S. A. E. 1035 steel appearing on the macrosections in Figs. 1 and 2. Only the maxi-

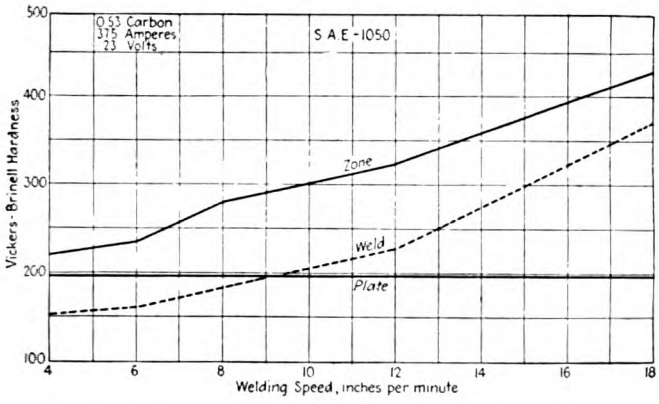


Fig. 8—Hardness curves for S. A. E. 1050 steel (0.53 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 9 in. per min.

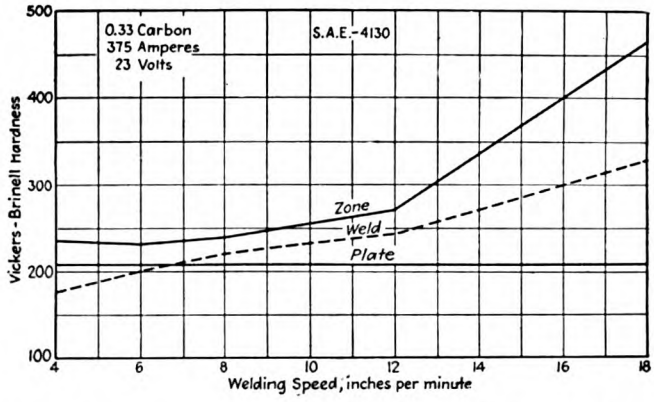


Fig. 10—Hardness curves for S. A. E. 4130 steel (0.33 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 13 in. per min.

mum hardness figures for each specimen are plotted on the curves in Fig. 6. For example, by referring to the top view in Fig. 2, which shows the complete curves for S. A. E. 1035 steel welded at a speed of 12 in. per min., the following values are obtained by tracing the three lines of impressions through the hardest area of the heat zone: Hard zone, 212 Vickers-Brinell; weld, 185 Vickers-Brinell, and plate, 137 Vickers-Brinell. These hardness figures are shown on Fig. 6 for this speed of 12 in. per min. The other points on these curves are obtained in the same manner.

Microscopic views of this steel are shown in Fig. 7. The structure ranges from large-grained pearlite at the slower welding speeds to fine-grained sorbite at the higher rates. The balancing of microstructure and hardness seems to take place at the 6-in. and 8-in. speeds. Large grain size, such as appears in the specimen welded at 4-in. per min., is not especially objectionable in plain

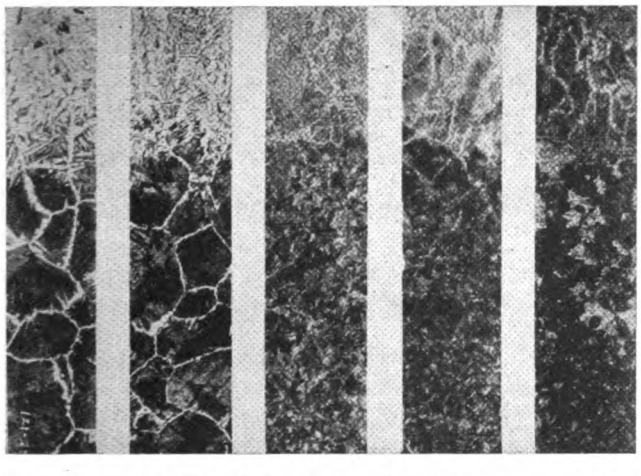


Fig. 9—S. A. E. 1050 steel (0.53 per cent carbon) etched with 1 per cent Nital x 150. Left to right these views show microstructures for welding speeds of 4, 6, 8, 12 and 18 in. per min. with sorbite to troosite, and sorbite to troostite with patches of martensite with decreasing grain structure. Fine grain structure at the top of each view is the weld area while the coarse grain structure is the plate area

carbon steels, only as it brings out a dissimilarity in the grain structure between the affected area and the rest of the plate. The characteristic columnar appearance of weld metal deposited with bare wire and not subjected to further heat treatment may be seen at the top of each illustration.

The hardness curves of the highest-carbon steel examined in this series of plain carbon steels is shown in Fig. 8. The rapid rise in hardness as the welding speed is increased is typical of high hardening power which 0.53 per cent carbon imparts to steel. In order to maintain a close relationship between the hardness of the heat-affected zone and the base metal, the slower welding speeds must be maintained. Fig. 8 shows that the hardness of the weld metal at the slower speeds drops below that of the plate. Such a condition is a result of the selection of one type of bare electrode wire for all steels in this entire series. This was done in order to keep constant the grade of welding wire for the steels and eliminate the wire as a variable in comparing the weld effect on the base metal only. After all, the problem had to do with the plate in this study and not with the deposited metal. However, it is reasonable to assume that with the use of a suitable high-strength rod, the weld hardness would, in general, keep pace with the hardness of the affected plate.

The photomicrographs in Fig. 9 indicate hardened steel at the higher welding speeds. The structure ranges from sorbite to troostite, and to troostite containing patches of martensite; the latter structure is shown in steel welded at 18 in. per min. Such a steel should be welded with caution wherever the welding of this steel is necessary.

Low-Alloy Steels

Welding brings about a drastic heat treatment in the plate steel adjacent to the weld to an extent depending upon the composition of the metal and the welding pro-

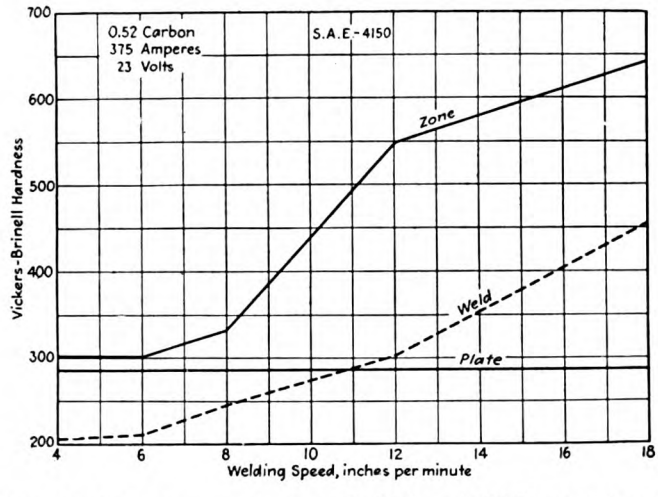


Fig. 11—Hardness curves for S. A. E. 4150 steel (0.52 per cent carbon). Maximum allowable welding speed based on 100 points Brinell = 8 in. per min.

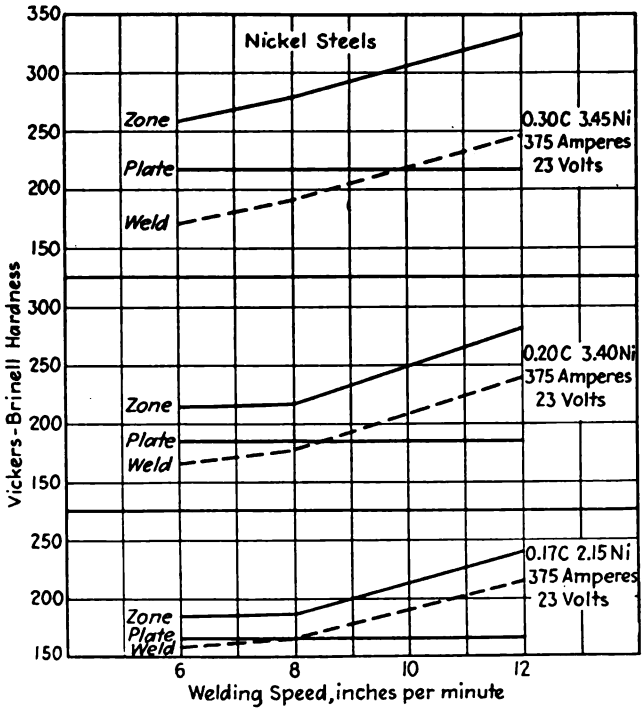


Fig. 12—Hardness curves for welding nickel steels, showing effect of different percentages of carbon and nickel

cedure used. Since most special steels respond readily to heat treatment, it seems reasonable to expect that the welding conditions should receive considerable attention in order to attain the minimum amount of hardening in the affected area.

A chromium-molybdenum steel with 0.33 per cent carbon (S. A. E. 4130) was welded by depositing beads as described for the plain carbon steels. The hardness values for the usual range of welding speeds is shown in Fig. 10. It should be noticed specially that the hardness curve for the hard zone is relatively flat up to the 12-in. speed.

In Fig. 11 the hardness of the same type of alloy steel is illustrated, but here the carbon content is 0.52 per cent (S. A. E. 4150). These curves show the effect of carbon to be more pronounced when joined together with alloying elements. The maximum hardness is 642 Vickers-Brinell and the allowable welding speeds are limited to the lower range. It is apparent that care should be taken in welding this steel in order to avoid shop or service cracks resulting from high hardness and unequal physical properties.

Stress relieving does reduce the hardness of such a weld-effect area, but stress relieving cannot heal cracks already formed in any steel whether they are produced by heat effect or any other cause.

The nickel-alloy steels have been investigated in this

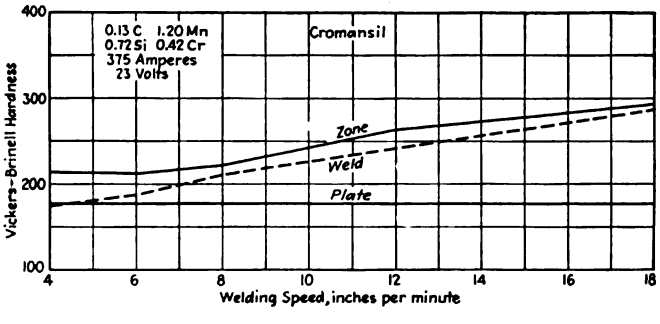


Fig. 13—Hardness curves for Cromansil steel. Maximum allowable welding speed based on 100 points Brinell = 15 in. per min.

study in view of their adoption by the A. S. T. M. The hardness curves in Fig. 12 illustrate the effect of carbon in combination with nickel in influencing the heat affected zone. Again low carbon is helpful as the hardness is decreased materially at any of the welding speeds shown. This is evident after an examination of the top and middle charts. With the same nickel content, the reduction in carbon from 0.30 to 0.20 per cent drops the curve substantially. The bottom chart shows that lowering the carbon still further and also decreasing the nickel, brings a closer relationship between the plate and the heat-affected zone.

Another alloy steel known to the trade as Cromansil steel is also included. The hardness curves are shown in Fig. 13. This is a low-carbon alloy steel, containing 0.13 per cent carbon with alloy additions of chromium, manganese and silicon. The slope of the hard-zone curve is gradual and the maximum variation between the 4-in.-per-min. and the 18-in.-per-min. speed is 75 points Vickers-Brinell. This steel lends itself readily to considerable latitude in the welding conditions. For tensile

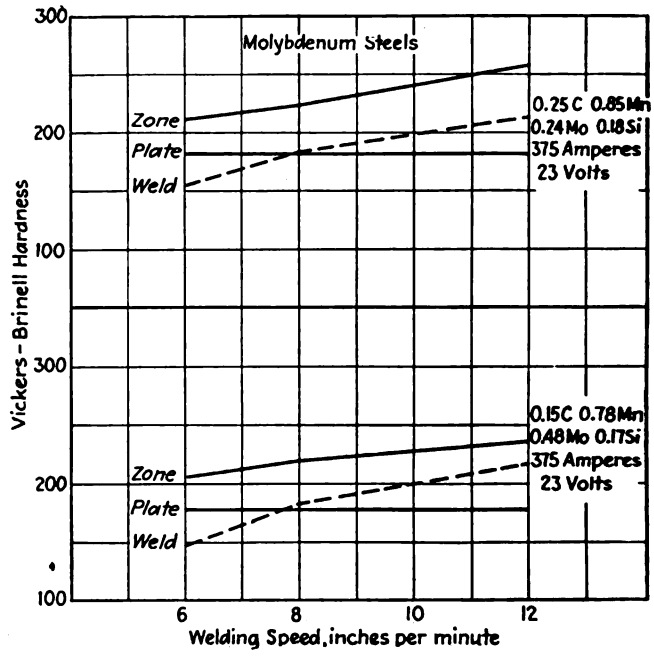


Fig. 14—Hardness curves for Molybdenum steels, showing the effect of decreasing carbon content and increasing the Molybdenum content

properties of 75,000 to 90,000 lb. per sq. in., such a steel combines strength without serious hardening in the weld-effect area.

Another alloy steel which has been approved recently by the A. S. T. M. is carbon-molybdenum steel. The Lukens Steel Company reports that this grade of steel, as made by them, has a tensile strength of around 80,000 lb. per sq. in. in the as-rolled condition and about 75,000 lb. per sq. in. after stress relieving. Carbon-molybdenum steel is used where high strength and ductility are required and where the hardening of the plate metal adjacent to the weld must be reduced to a minimum.

Fig. 14 shows the hardness curves of two analyses of this steel. The 0.15- to 0.25-per cent-carbon steel with 0.50 per cent molybdenum has been the most popular and best suited for welded fabrication. Since these curves were drawn, additional work has been done in extending the hard-zone curve of the 0.15-per cent-carbon steel, and the maximum variation in hardness from welding speeds of 4 in. to 18 in. per min. was found to be 65 points Brinell, or from 200 to 265 Brinell.

Carbon-molybdenum steel is being made into plate 4½

in. thick with 0.50 per cent molybdenum and the carbon ranging from 0.20 to 0.25 per cent for a minimum tensile strength of 70,000 lb. per sq. in. Carbon-molybdenum steel has been used in the refinery and boiler fields and in heavy plate for stationery boiler service.

A number of welding engineers have commented on the ease with which low-carbon molybdenum steels have been welded. If it can be proved that molybdenum substantially aids the weldability of steel, then this fact, together with its ability to keep hardening in the affected zone of the plate adjacent to a weld extremely low, makes carbon-molybdenum steel highly desirable for welding.

Aklo Heat-Absorbing Glass

With increasing attention being paid to the adequate insulation of modern railway passenger equipment, designers look critically on the large amount of window space which constitutes about one-third of the entire side and end wall area of a car. A comparatively new development, adapted to afford substantial assistance in solving the problem of heat transmission through windows, is a heat-absorbing glass, known as Aklo and made by the Libbey-Owens-Ford Glass Company, Toledo, Ohio.

Aklo is a plate glass of special chemical composition that gives the glass the ability to absorb infra-red light rays. It has a special coefficient of expansion, transmits a high amount of visible light and has a slightly greenish cast. In sunlight, the infra-red rays are heat rays and include one-half of the heat from the sun. Thus, Aklo absorbs approximately one-half of the heat of the sun's rays. When a ray of sunlight passes through glass, 5 per cent of the heat is reflected by the surface of the glass, 48 per cent is absorbed by the pane of Aklo, and the remainder, equaling only 47 per cent of the original sun's heat, is transmitted directly through the Aklo glass. These percentages are clearly indicated in the illustration which shows a ray of sunlight transmitted through a double glazing of Aklo and ordinary glass. When the ray of sunlight has passed through the outside pane of Aklo, it carries only 47 per cent of the sun's original heat, and as it passes through the pane of ordinary glass on the inside, 5 per cent of the heat is again reflected, resulting in only 42 per cent of the heat in the original sun's rays falling directly on the passengers or interior of the car. This promises to answer in a large measure the problem of insulating passengers from the uncomfortable direct summer sun rays.

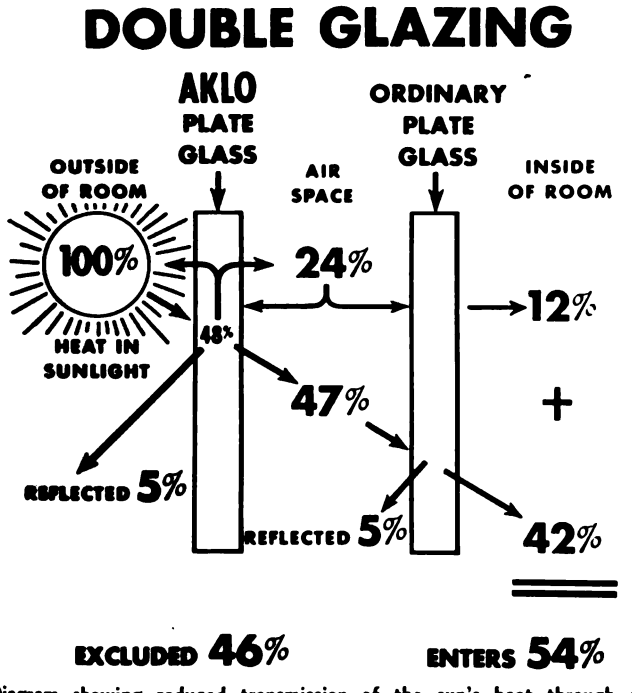


Diagram showing reduced transmission of the sun's heat through a double-glazed window, comprising one pane of Aklo plate glass and one pane of ordinary plate glass

If the railway car is air conditioned, this glazing system will also have an economic effect in reducing the car's air-conditioning costs. By reference to the diagram, it will be seen that of the 24 per cent of the sun's heat which is conducted toward the inside of the single pane of Aklo glass, that amount of heat only will be conducted into the air space in the recommended double glazing. This 24 per cent will then be again conducted half inside and half outside, or 12 per cent of the sun's heat will enter the car through conduction. Thus, the Aklo double glazing will allow a total of only 54 per cent of the sun's heat to enter the car, and thereby favorably affect air-conditioning costs.

Tests conducted at the University of California are said to have shown that, under maximum summer sun rays in that locality, ordinary glass transmitted 325 B.t.u. per sq. ft. per hr. Under the same conditions, it was found that Aklo glass transmitted only 195 B.t.u. per sq. ft. per hr., thus indicating how air-conditioning costs will be reduced and passenger comfort increased by the use of Aklo heat-absorbing plate glass. The use of this glass also tends to reduce the formation of condensation in double-glazed windows.

Railway Equipment Service Failures

(Continued from page 174)

cut into the fillet. Instances of this sort emphasize the fact that every possible precaution must be taken, from start to finish, to make things of this kind impossible.

At the risk of becoming tiresome I want to again emphasize the fact that square corners are an abomination on any reciprocating part, and frequently also in the case of simple revolving parts. A steel manufacturer had complaints that his steel was of poor quality and an investigator was sent out to study the case. He found that spindles used in a manufacturing plant, made from his steel, were failing in large numbers, whereas the spindles originally supplied by the manufacturers of the machine failed only occasionally. Critical examination indicated that the original spindles had a well proportioned, smooth fillet, while the ones made from his steel by a machinist in the spinning factory machine shop had a square corner in each case. Instructions were given to see that proper fillets were made and no further complaints were received as to the quality of the steel.

An improperly finished axle on a locomotive may cause a wreck costing a quarter of a million dollars. Improperly finished parts on locomotives and railroad equipment may cause damage varying all the way from this high sum to $15 for a new crank shaft on a modernized hand car, plus the time and service wasted because of having no fillet, or a poorly and roughly made fillet. Surely this potential source of trouble and expense is worthy of the most careful and critical attention on the part of the designers and all those having to do with the manufacture and maintenance of such parts.

EDITORIALS

Modern Facilities Needed More Than Ever

The current recession in business, with its accompanying necessity for the curtailment of expenditures for maintenance of equipment brings home again to every shop and enginehouse supervisor the increasing difficulties of providing serviceable equipment and keeping it within the limited expense budgets. It has also brought home the fact that, in some respects, many roads are not in as favorable a position to meet the present situation as they were in 1932 and 1933.

An analysis of maintenance operations, as far as locomotive repair work is concerned, for the past two and one-half years will disclose the fact that most roads did a remarkable job of keeping pace with the increased volume of traffic during that period and at the same time were able to catch up to some extent on deferred maintenance. Under present conditions of operation it is quite probable that the roads are again running out considerably more locomotive mileage than they are restoring.

Many things have happened since 1930 that have a marked influence on the ability of a road to maintain motive power in normal condition. By that is meant the ability to restore each month as much locomotive mileage as, or a little more than, has run out and to maintain available mileage at least at 50 per cent of the potential, or assigned, mileage. In the intervening seven years the locomotive inventory has increased in age, because the normal number of replacements has not been made each year. Increased age, in itself, would not be so serious were it not for the fact that the unit costs of maintenance go up with the increase in age. Therefore, on the age basis alone the average locomotive of 1938 will cost more to maintain than the average locomotive of 1930. In addition, the facilities with which locomotives are maintained in the enginehouse and in the shop have not only grown older, less productive, and more expensive to maintain, but the situation with respect to replacements is more serious than with motive power, for the reason that the relatively small amount of excess funds available for capital investment has, of necessity, been spent mostly for motive power and rolling equipment. This statement is made with proper regard for the fact that more shop machinery and tools were purchased in 1937 than in any year since 1929. But, it must also be remembered that 10 per cent of the shop-machinery inventory of 1930 has been retired because of obsolescence.

Aside from the above factors, railroad freight rates, while recently slightly increased, have been inadequate and substantial increases have been made in taxes and in wages. The increase is particularly significant when its effect is traced down to shop operation. Just as an example, the allowance for labor on a Class 3 repair job on a modern locomotive in a certain shop was approximately $4,500. At the wage rate existing before the recent advance this amount would produce about 375 man-hours of labor more than it could pay for at the present time. These 375 man-hours may more easily be visualized when it is pointed out that it amounts to over 46 eight-hour days. Any foreman can understand what this means in terms of work accomplished. To the foreman of today it also means work that may not be done.

The plain facts of the present situation can not be ignored. Every railroad man, from the general manager to the gang foreman, knows that it is impossible to continue for long to spend more than is earned. In an operation such as that of repairing locomotives a large part of which is a mechanized job, there is, fortunately, a solution by way of the installation of modern shop facilities. The present conditions afford an opportunity to study the value of such facilities.

Who Gets the Wage Increases?

On April 29 the Association of Railway Executives announced its decision to proceed under the provisions of the Railway Labor Act to secure a 15 per cent reduction in wages of railway employees. This action was taken following the refusal of the railway labor executives to discuss a voluntary—and temporary—wage reduction with the railway executives. Under the provisions of the Railway Labor Act the railway executives are required to give employees formal notice of a proposed reduction and to bargain collectively with the representatives of the employees. If both collective bargaining and intervention by the government's mediation board fail, either of the parties may decline to arbitrate. Following such an impasse the President may appoint an emergency board to hear both sides and report with recommendations which, however, are not binding on either side. Following a delay of 30 days the railways may then put the proposed reduction of wages into effect.

Throughout the several months required for the completion of this long process, no doubt, appeals will be made for the support of public opinion by both sides. Just how public opinion will crystallize in the end is a

matter which only the future will determine. There are some indications, however, that the public regards railway employees as a very highly favored group and is inclined to believe that they are probably too highly paid under present circumstances.

This trend in public opinion is based largely on the present status of the train-service brotherhoods, who are the "railway employees" in the popular mind. The present compensation of other groups of railway employees is probably not out of line with that of employees in industry generally. A strong case can be made out, however, for the proposition that wages throughout industry are too high for the greatest good of the greatest number of the wage earners themselves under present conditions. High wages in industry entail high prices of the products of industry. If all persons were employed by industry, the effect of high wages would in a measure be self-canceling. There are many groups in our population, however, whose earnings are not benefited by the wage increases of industrial workers. To them higher prices means curtailed consumption of industrial products and this means fewer jobs and less earnings for those whose wages have been increased.

This is the way it works out in industry, particularly at a time when demand is at a low ebb and there is a general lack of confidence. The railroads, however, have no control over the prices they charge for their services. To offset the wage increases of last summer and fall they asked for a rate increase. But the amount of the increase finally granted by the Interstate Commerce Commission is inadequate to offset the increase in expenses caused by the wage increases. With this lack of control of the price they charge for their services they are left with no recourse but to cut all expenses to the bone. This means less work for railway employees, particularly those employed in maintenance operations in which the effect of considerable postponement can be absorbed without disastrous consequences.

From the standpoint of railway-shop employees a decrease in wages such as the railways are asking for will not be without its favorable aspects. Unlike the train-service brotherhoods, whose employment is largely controlled by the volume of traffic offered to the railroads, a reduction in wages will effect some increases in employment in equipment-maintenance operations. The favored employees who have not been laid off may suffer some decrease in monthly earnings but this will probably not be as great proportionately as the cut in their hourly rate. Other employees will be taken back, however, and in all probability the greatest good to the greatest number of employees themselves will thus be best served.

This is merely a reversal of the process which took place last fall. Following the wage increase to the non-operating employees, there were immediate reductions in the hours of shop labor paid for by the railroads which brought back the total compensation paid to approximately the figures prevailing before the increase went into effect. On the other hand, when the increase in the wages of the train-service employees went into effect in October, they were accompanied by an increase in the hours of labor paid for because there was an increase in the volume of traffic during that month.

And when the time comes for consideration of a restoration of any part of such reduction in wages as may become effective during the next few months, the 83 million dollars (in 1937) which the road train-service employees received for time not worked should not be forgotten.

How About Apprenticeship?

Early in the present century the New York Central and the Santa Fe set the pace for the railroads—and industry as well—in introducing improved apprentice training methods in the mechanical department. George M. Basford, with statesmanlike vision, foresaw the need of better trained workers in the mechanical department as locomotives and cars were increased in size and capacity and improved in the interests of greater efficiency and economy of operation. His advocacy of better apprenticeship methods, in his paper before the American Railway Master Mechanics' Association in 1905, and his continued hammering on this question in the columns of the American Engineer and Railroad Journal, the predecessor of the *Railway Mechanical Engineer*, were largely responsible for having available in railroad service during the World War and postwar years, a reasonably good supply of well-trained mechanics and also a large number of well-equipped supervisors, who had been developed more or less as a by-product from the improved training systems.

What about the mechanics for tomorrow? The number of apprentices was greatly reduced during the depression, and in the effort to hold down expenses most of the training systems were largely thrown into the discard. These facts are generally recognized and have been a matter of great concern to railroad mechanical department officers. The difficulty is accentuated by the fact that marked progress has been made in locomotive and car design to meet the exacting present-day conditions, and that higher standards of workmanship must be insisted upon in the future. In addition to complications in the design and the addition of special equipment, new materials have been introduced which require special treatment and changes in maintenance and shop practices. In many instances much closer tolerances must be observed.

Apprentice training methods should be introduced which will protect this situation and furnish an adequate supply of well-trained mechanics for the future. A rough survey indicates, however, that in most instances the railroads have gone back to almost primitive methods in dealing with the apprentices. This is re-

flected to a certain degree in the extracts from letters from apprentices which will be found upon the Gleanings page of this issue. Unfortunately, reports from industry indicate that much the same thing is true in other fields, although a determined effort is now being made by the Federal Committee on Apprentice Training of the United States Department of Labor to improve the situation. A number of states have now established apprenticeship councils to study conditions within the individual states and to stimulate a larger interest in these matters on the part of industry at large. Certainly there is no lack of evidence on the railroads as to the value and importance of the work done by well organized apprentice training systems in the past, and to warrant a resumption of this activity, and in a way which will meet modern conditions, on a sufficiently large scale to furnish the more highly trained personnel which will be required in the future.

Servicing Streamline Trains

The proper servicing of passenger trains at terminals has always constituted an important and quite expensive operation, greatly augmented in recent years by the large proportion of air-conditioned equipment which involves provision for precooling, re-icing, or attention to mechanical details, in the case of power-operated air-cooling apparatus.

To the above requirements is now added the necessity of unusually quick turn-around service, in order to secure maximum availability and use of expensive modern trains. The necessity of careful planning and organization of terminal car-handling forces for the satisfactory performance of this work is obvious. An adequate force of employees, experienced in the cleaning, inspecting and repairing of these trains, is of fundamental importance and, when the layover time is exceptionally short, it is frequently necessary to start this conditioning work almost as soon as passengers are out of the arriving trains.

Next to an effective terminal organization, and in some respects even more essential, is the provision of adequate mechanical facilities, located adjacent to passenger terminals, and designed to facilitate the quick and effective performance of all inspection and repair operations. The experience of the Chicago, Burlington & Quincy in handling its fleet of Zephyr trains at the Chicago terminal, for example, has indicated the value of installing repair tracks of adequate length, preferably equipped with inspection pits and necessary drop-pit and crane facilities for changing wheels, or if necessary complete trucks.

Another example which might be cited is the Daylight trains of the Southern Pacific which are inspected, cleaned and serviced in the Pullman cleaning yard at San Francisco, Cal., where a raised inspection and repair track has been provided for the efficient handling of this work. The track was raised by placing 12-in. timbers longitudinally over the ties with rails on top of the timbers and a gradual slope at each end to the level of other tracks. This raised track provides an excellent opportunity for the critical inspection and repair of all parts of the trucks, brakes and air-conditioning equipment below the underframe. Two hydraulic-operated drop tables are provided on this track for the quick change of wheels when necessary.

On each side of the Daylight servicing track, there is a concrete pavement with suitable gutters to take care of the large amount of water which is required to wash the train thoroughly every night. Electric lines, with outlets for charging and testing, and easily accessible water and steam connections are also provided. A general overhead lighting system gives ample illumination for exterior cleaning, and portable electric lights are available for lighting underneath the cars and for other use where special illumination is required.

Portable-cleaning platforms on wheels, as well as portable material and tool wagons, afford a means of servicing and cleaning the car exteriors at a minimum cost. The interior of the train is serviced by assigned, specialized crews, vacuum cleaners being used exclusively for cleaning carpets, upholstery and drapes and thus avoiding unnecessary circulation of dust in the cars.

Unquestionably the provision of all of the mechanical and labor facilities needed for the efficient servicing of modern passenger trains introduces a large element of cost into railway operation but, considering the high first cost of the equipment and the necessity of getting adequate returns on the investment, as well as meeting the exacting demands of the public, it is obviously false economy to stint on expenditures essential in modern passenger-car terminal-servicing operations.

New Books

MECHANICAL WORLD YEAR BOOK, 1938. *Published by Emmott & Company, Limited, 31 King Street West, Manchester, England. 210 pages, 4 in. by 6½ in. Price, 1/6 net.*

An entirely new section on the subject of Electric Arc Welding is contained in the 1938 edition of the Mechanical World Year Book. It describes the types and properties of electrodes, explains the process in detail, and gives instructions for the various methods of welding and for welding in different positions. Welding design is also discussed and methods of calculation given for butt and fillet welds. In order that two consecutive editions of the book might provide a greater store of data, sections are now alternated. In the 1938 edition the section on Presswork, omitted from the 1937 edition, has been brought back and the section on Metals and Alloys omitted.

Gleanings *from the* Editor's Mail

(The Apprentices Speak)

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Shoddy Apprentice Training

Instead of the various shop foremen sticking to the schedules, they put us on jobs and then forget about us. We either have to remind them about our time being up on that certain job, or else remain there until we are so far past the date of changing that we lose out on some other position in the shop. Is this fair to us?

Encourage Apprentices to Study

Give apprentices more time in classroom study during working hours, with proper supervision to combine classroom theory with shop practice. Have speakers, experts in their fields, talk to the apprentices at regular meetings. Create an incentive among the apprentices for outside study. Have regular periods of visitation to other repair shops or other industrial plants to see how it is done elsewhere.

Technical Training Overlooked

The officials concerned do not take the interest they should in teaching their future machinists. We apprentices deserve more book work, to explain the technical side of some of this machine work. All they seem interested in is securing a good day's work, regardless of what kind it may be. I think they should supply us with printed material to explain this work along with the actual experience. As it is, all we get we have to secure ourselves.

Apprentice Critical of Conditions

The place in which we study is poor. It is dirty and has improper lighting and ventilation. I would not ask anyone to make a neat drawing when everything you touch is covered with coal smoke. When I applied for a job as apprentice the application called for the type of work wanted. I didn't even know what they had to offer, so I put down machinist. I would suggest a list of the training offered, wages paid, amount of time required to complete a course for the young applicant to read. He would know then what he was getting into and what was expected of him. I worked six months before I obtained all of this information.

An Investment for the Future

It is my opinion that the apprentice is too often used as a means of low-cost production, rather than as a student preparing to be a future skilled workman. Also, it seems that apprentice training could be improved by encouraging the student to make more of a study of his work. By this I mean that he should be given the opportunity to read books pertaining to his work and to spend additional time outside of working hours in study. With this in mind, it would necessitate the choosing of boys who are ambitious and apt to learn. Those employing apprentices should take greater interest in them and make every attempt to properly educate them as an investment for the future.

Furloughed Apprentices

Since we have been furloughed I have kept in touch with several of the other fellows and, like myself, they have found it difficult to secure employment. There are several reasons for this. For one, work is generally slack, as everyone knows. Second, not having finished our apprenticeship, concerns have little desire for our service. And lastly, the fact that we are employed by the railroad; we have found that most concerns won't even accept an application from us, because they claim that when the railroad sends for us again we will return. They claim that this turnover in labor is costly and decreases plant efficiency.

Few Apprentices Know "Why"

In the earlier days regular apprentices were given more training in blue print reading, drawing and a better understanding of mechanism or the fundamentals of electricity. Today their work consists mainly of actually doing the work after observing the machinist or electrician do it. Few know "why" they do what they do and the majority have gained the attitude of "who cares". This attitude could be overcome by giving encouragement to those apprentices who take the initiative to go to some night school to better themselves for their work, rather than let the apprentice go four years with the idea that he'll get no further than the one who does not broaden his thinking ability.

Give Apprentices More Seniority

There is little assurance when an apprentice completes his time that he will have a job awaiting him. With the seniority rule in effect and recent reductions in forces to stabilize employment making for a long list of laid off employees, the apprentice with but one year of seniority (as a mechanic) granted him for three or four years of service, has a small chance for regular employment with the company he served his time for. It seems to me that if a company spends a sizeable sum in training a man it should take steps to retain him when he finally becomes valuable to them because of experience, gained during his training. A step in the right direction that might help would be to give a graduate apprentice more seniority.

More Trained Mechanics Needed

I read an article in the *Railway Mechanical Engineer*, written by an official of the Denver & Rio Grande Western (H. J. Schulthess, in October, 1937, issue, page 437) on apprentices and their training. This official stated that what the mechanical departments of the railroads needed today was trained mechanics, and that the only way to get trained mechanics was through apprenticeship training. I thoroughly agree with this, but evidently some of the officials of our road do not. If they would get out of their offices and come to the various shops to check up on the work being done by their mechanics today, I am sure that they would also realize that what the mechanical department needs is more trained mechanics.

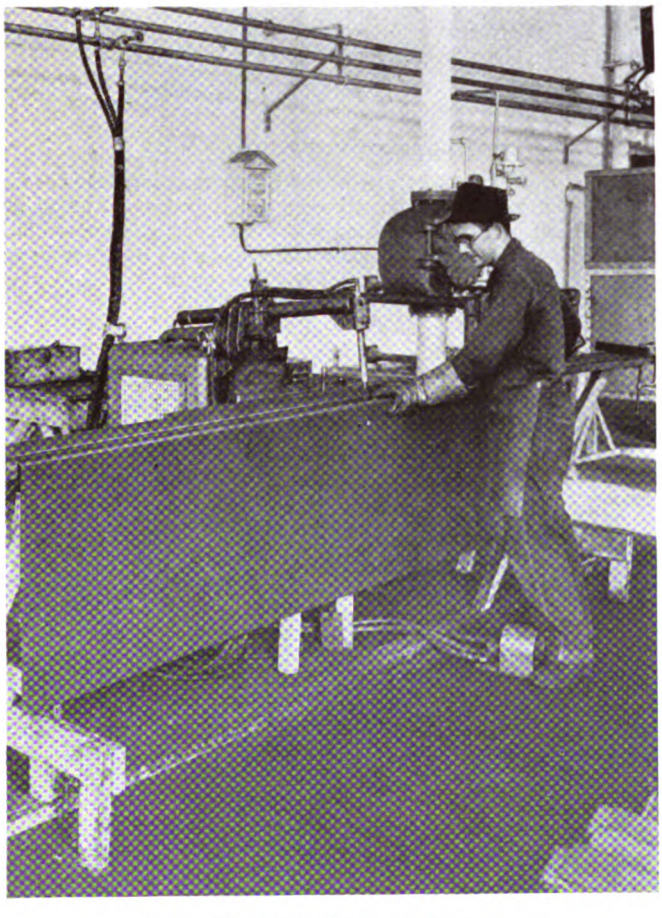
With the Car Foremen and Inspectors

Building

Light Welded Box Cars

Pullman-Standard utilizes special welding jigs and equipment in constructing 200 cars at Michigan City Plant

Two hundred lightweight welded 50-ton box cars, now being built by the Pullman-Standard Car Manufacturing Company at its plant, located at Michigan City, Ind., are notable not only for their efficient lightweight welded design but because the structural materials and fabricating methods used promise unusual serviceability, long life and freedom from maintenance cost. The car design, developed by Pullman-Standard after extensive research and experiment over a period of several years, effects a saving in weight of about 4½ tons from that of a conventional Association of American Railroads standard box car of the same dimensions.



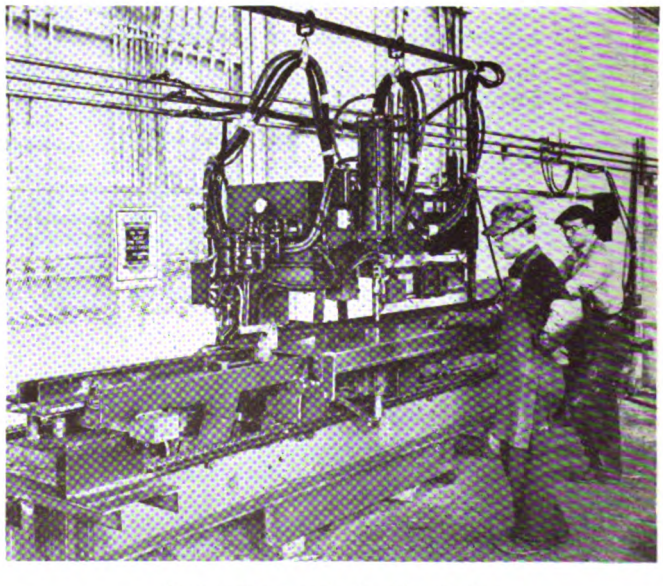
Spot welding miscellaneous side parts

The car is made of high-tensile low-alloy steel, utilizing arc welding, spot welding and riveting wherever each can be employed to the best advantage. The approximate footage of each, per car, is as follows: arc welding, 1,030 ft., or 27.7 per cent; spot welding, 2,601 ft., or 70 per cent; riveting, 90 ft., or 2.3 per cent. The car, though normally of 50 tons' capacity, will actually carry 133,400 lb. of revenue load. It has the following dimensions: inside width, 9 ft. 2 in.; inside length, 40 ft. 6 in.; inside height, 10 ft. ½ in. The car weighs 35,600 lb., and has a ratio of lading to rail load of 78.9 per cent, which may be compared with 73.7 per cent for the A. A. R. car. Comparative weights of detail parts in the two cars and the structural materials used are shown in the table.

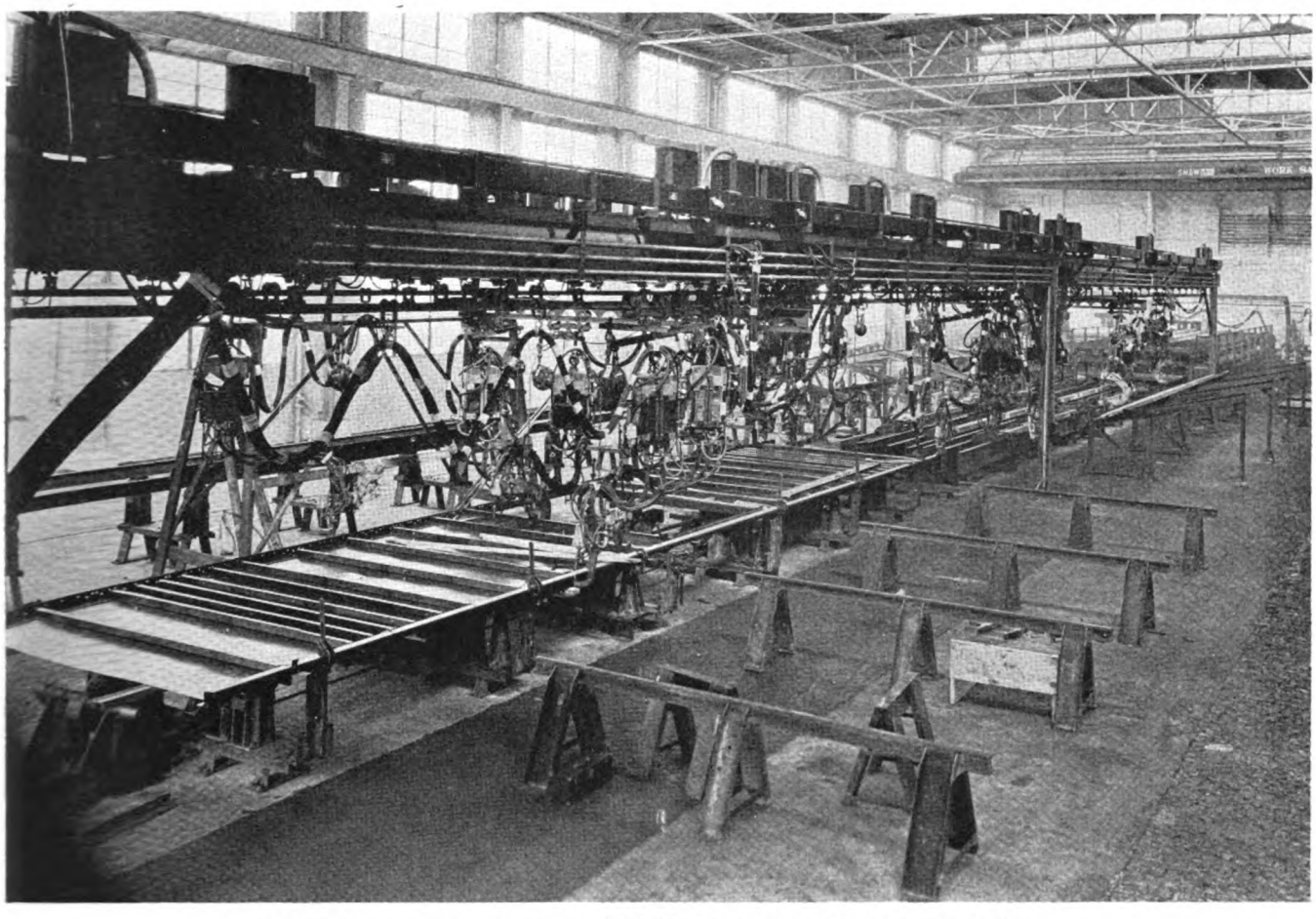
Spot-Welding Operations and Equipment

In order to produce these lightweight welded cars, a new shop was erected and a considerable amount of automatic and portable spot-welding equipment installed. With the exception of the roof application to the steel body, all spot-welding work is concentrated in this one building.

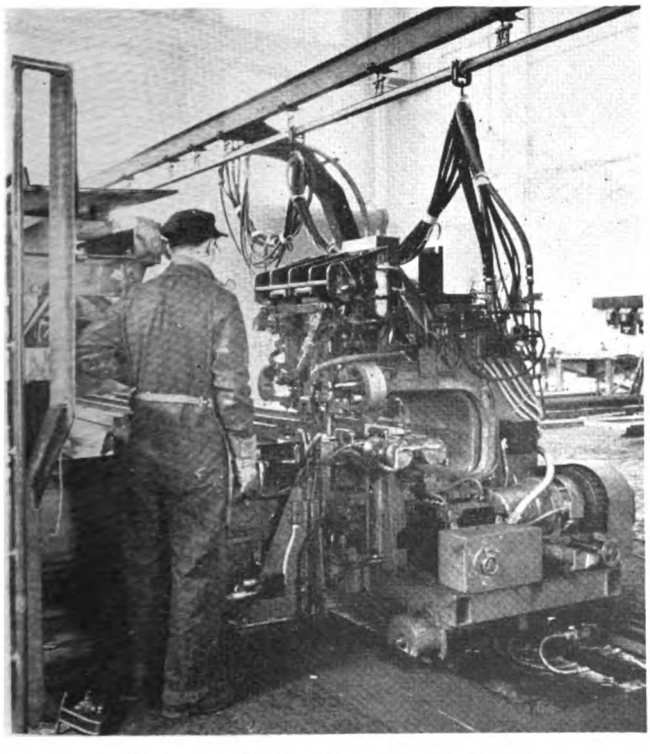
The resistance spot-welding method used is one in which the parts are overlapped and gripped between two electrode points through which a heavy current is passed and pressure applied to make the weld in a single spot. The temperature, timing, and pressure varies according to the type, thickness, and number of layers of material.



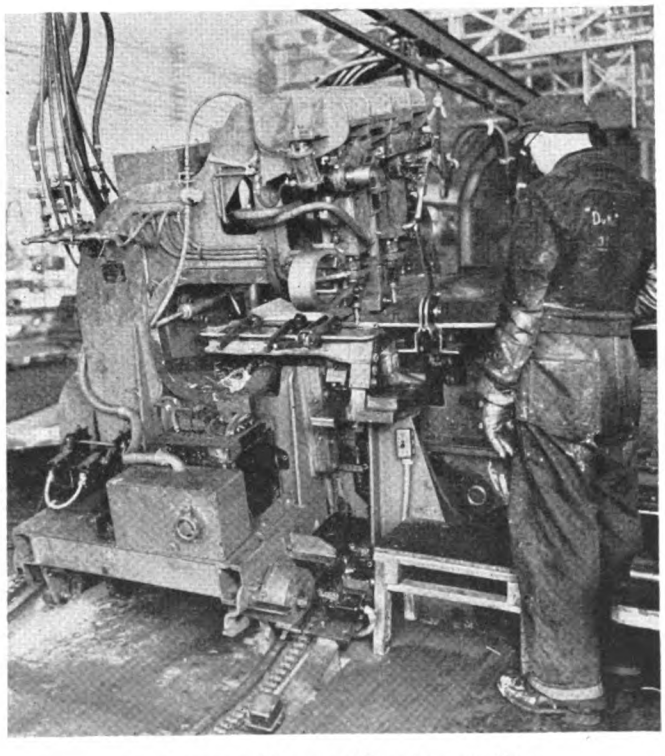
Spot welding posts to side sheets



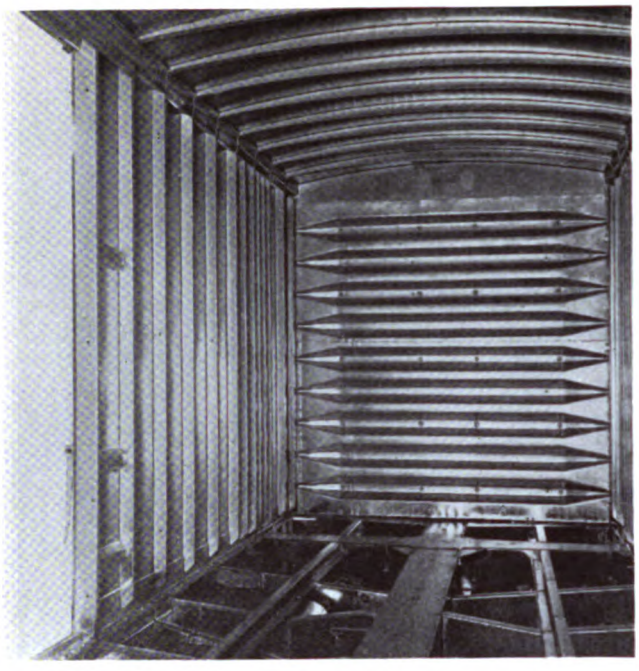
Special jigs and equipment used in fabricating complete car sides by spot welding



Side-sheet spot-welding machine in operation



Roof spot-welding machine in operation



The assembled car structure

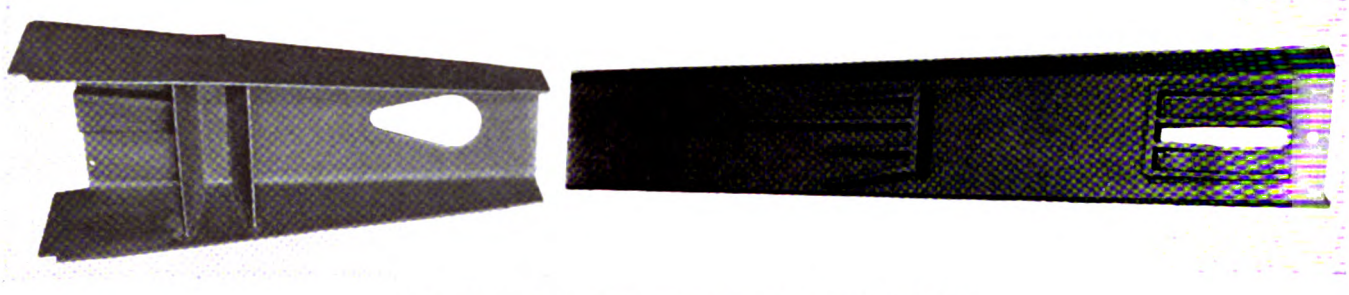
Every main and sub assembly is made in a special jig to assure uniform accuracy.

Close supervision, continued inspection, and daily testing of welds is carried on at all times to establish good welding. Each day a test spot-weld specimen is made by each machine and is tested to insure correct timing, temperature, etc. In addition, inspectors sound each button on every bench assembly to guarantee a continuous perfect quality of weld.

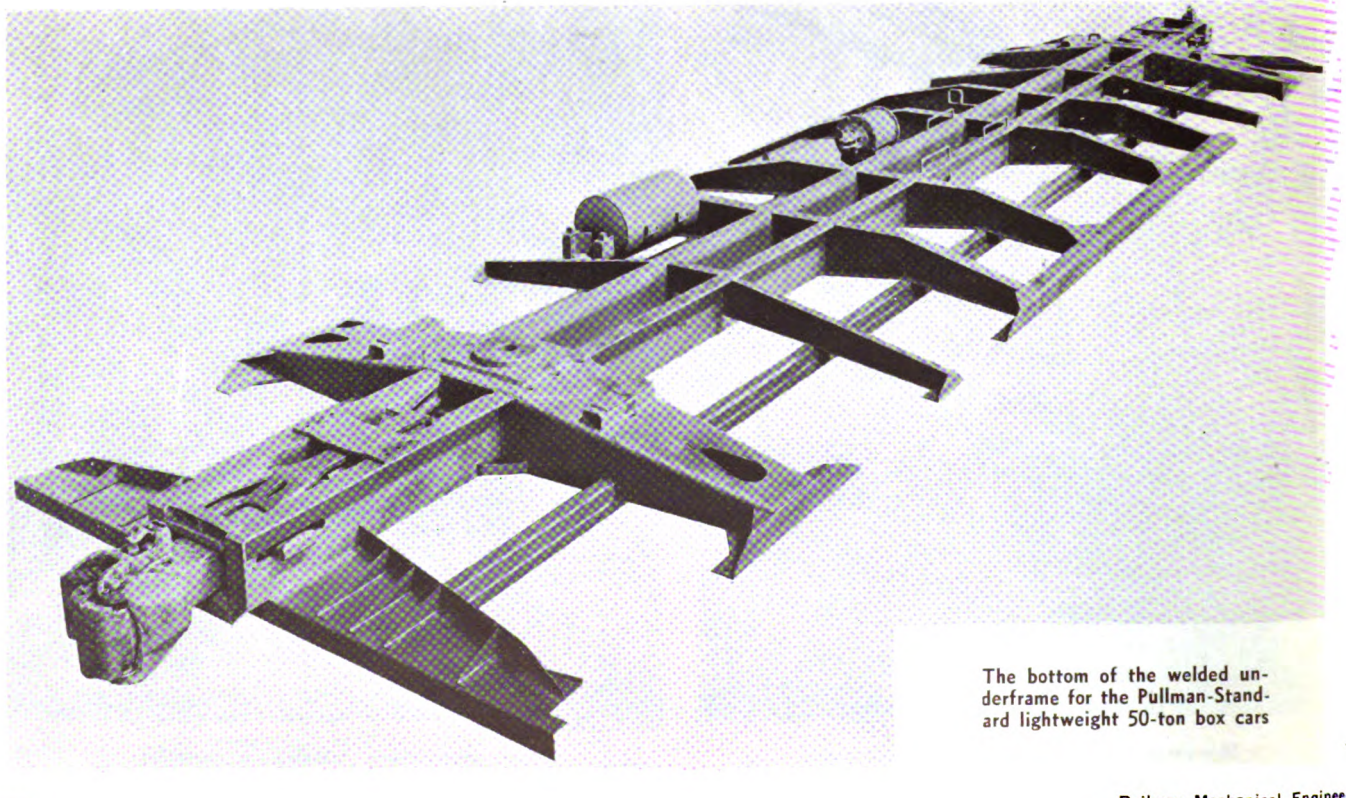
The spot-welding equipment, especially designed and installed to make use of this new method of building cars, includes two non-indexing automatic double-head 75-kv.-a. machines; two indexing automatic single-head 100-kv.-a. machines; four stationary spot welders, 50 kv.a.; nine portable tools, 100 kv.a.; and 18 portable tools, 75 kv.a.

The non-indexing automatic machines are used for spot welding the side-sheet assembly and the roof-sheet assembly. The indexing automatic machines are for the door-sheet assembly and the door-post assembly. The stationary spot welders are used for welding the reinforcements on the roof carlines and side posts, as well as for other small miscellaneous sub-assembly work.

All the machines and transformers were built by a company which has had long experience in construction and using this type of equipment. The electronic prin-



Left: Body-bolster diaphragm—Right: Arc-welded draft sill



The bottom of the welded underframe for the Pullman-Standard lightweight 50-ton box cars

ciple of timing is used on most of the machines, with air timing on the balance. The contactors and operating valves of the electronic timers are designed to meet the requirements of this particular service.

All of the portable tools were especially designed to handle some individual feature of sub and final assembly. These tools are used for applying the side plate, side sill, post connections, etc., to the sides. Other portables are also used for applying the roof to the car and the final assembly of the side doors.

The spot-welding machines range in capacity from 50 to 100 kv.a., most of the machines being rated at 75 kv.a. The electric power supply is at 60 cycles and 480 primary voltage. The welding current is made available at 14 volts, 5,000 to 6,000 amp. The mechanical pressure between sheets being welded varies from 700 to 4,000 lb. depending on the thickness of the material, the average pressure being 1,200 lb. The welding time varies from 6 to 45 cycles, depending on the type of tool and thickness of materials, with an average of 10 cycles.

Comparative Weights and Structural Materials Used in Pullman-Standard Lightweight Welded 50-Ton Box Car and A. A. R. Standard Car of Equivalent Capacity

	Pullman-Standard car	A. A. R. standard car
	Weights	
Car Body	21,000 lb.	29,100 lb.
Trucks	14,600 lb.	15,400 lb.
Complete car	35,600 lb.	44,500 lb.
Load limit	133,400 lb.	124,500 lb.
Ratio of lading to rail load	78.9 per cent	73.1 per cent
Underframe	5,797 lb.	7,879 lb.
Sides	3,532 lb.	5,933 lb.
Roofs	1,190 lb.	2,086 lb.
Doors	527 lb.	724 lb.
Door fixtures	415 lb.	556 lb.
Ends	1,209 lb.	2,350 lb.
	Material	
Side sheet	.05-in. H. T. low-alloy steel.	.10-in. O. H. steel.
Roof sheet	.05-in. H. T. low-alloy steel.	14-gage O. H. steel.
Door sheet	.05-in. H. T. low-alloy steel.	.10-in. O. H. steel.
End sheet—bottom	1/8-in. H. T. low-alloy steel.	1/4-in. O. H. steel.
End sheet—top	3/32-in. H. T. low-alloy steel.	3/16-in. O. H. steel.
End plate	1/8-in. H. T. low-alloy steel.	Integral with top sheet.
Center sills — AAR Z-section	31.3-lb. 11/32 in. thick, 18.4 sq. in., high-carbon O. H. steel, 36,000 lb. min. yield point.	36.2-lb. 13/32 in. thick, 21.3-sq. in. O. H. steel, 30,000 lb. min. yield point.
Side sills	6-in. by 3½-in. by 1/4-in. H. T. low-alloy steel.	6-in. by 3½-in. by 5/16 in. O. H. steel.
Side sill reinforcement	7/32 in. pressed channel.	6-in. bulb angle O. H. steel.
Side plate	5/32-in. H. T. low-alloy pressing.	3-in. O. H. steel Z-section.

In spot-welding the roofs and sides, welding rates up to 250 spots per min. in the double-head machine are attained. The spacing of spots on the sides consists of two rows, spaced vertically 3/4 in., staggered, with 7/8 in. between the rows of spots. The spacing of spots on the roof consists of two rows of spots, staggered 1 in., with 1 in. between rows of spots.

Arc-Welding Operations

The arc welding employed is the shielded-arc type in which coated electrodes are used. The type and size of rod depends on the position, size of weld, and kind of material. The jigs for arc welding are all constructed to permit down-hand welding.

Less than one-third of the welding footage in each car is made by arc welding, which is concentrated primarily in fabrication of the underframe, application of door fixtures, etc. The riveting employed is that along the corner post seam for the final application of the ends to the car and along the side sills for the final application of the sides to the underframe. At the present time, riveting appears to be more advantageous than either method of welding for these particular joints.

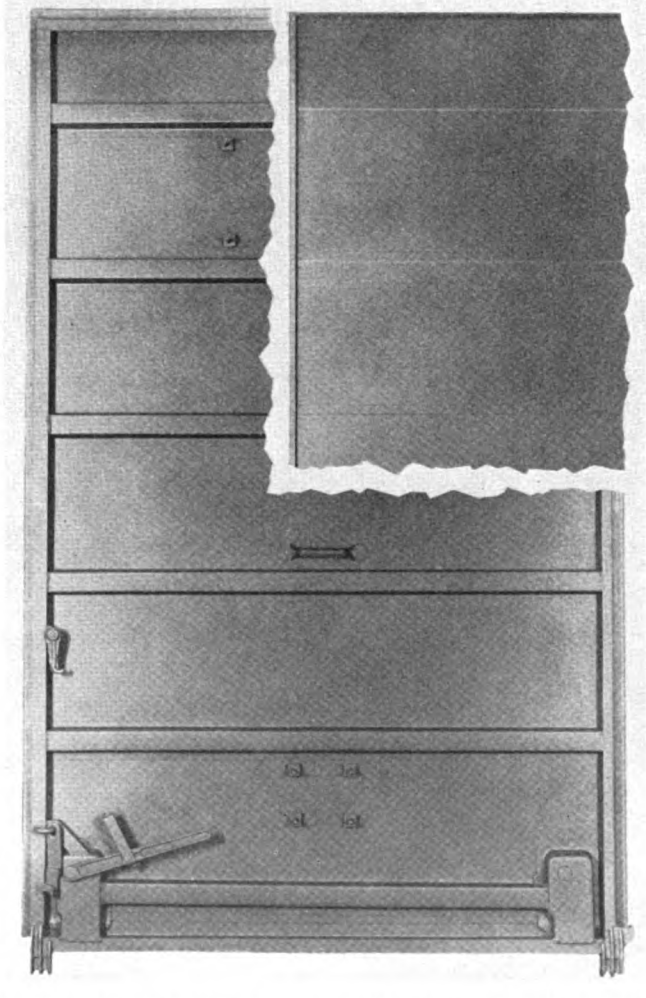
In the end-sill assembly, the end sill is a 1/8-in. Z-pressing, made of high-tensile low-alloy steel. The Z-shape gradually reduces in depth toward the side sill where it is joined and reinforced by a 1/8-in. flanged gusset. The web and depending flanges are stiffened by four 1/8-in flanged stiffeners applied on each side of the center sill.

In the side-post reinforcement assembly, the side sheets are .05 in. thick high-tensile low-alloy steel with Z-posts pressed integral and reinforced with .05-in. pressed angles.

In the side-sheet reinforcement assembly, the side sheet at the bolster is stiffened with two .05-in. high-tensile low-alloy steel pressed Z-sections reinforced with .05-in. pressed angles. The side sheet, next to the bolster is reinforced with one Z-bar and angle of the same design as that on the bolster sheet.

Other sub-assemblies include application of the auxiliary to the main door post, application of the auxiliary and main door post to the side sheet, and reinforcements to side sheet at the bolster.

In the automatic spot-welding of side sheets, the individual sheets are welded together with two rows of spots spaced vertically 3/4 in., staggered with 7/8 in. between rows of spots, as mentioned. The machine is designed to deliver the side-sheet sections automatically to the welding position where a composition flux is applied previous to spot welding in order to seal the joints.



The side door of the Pullman-Standard lightweight welded box car. A portion of the inside of the door is shown in the inset

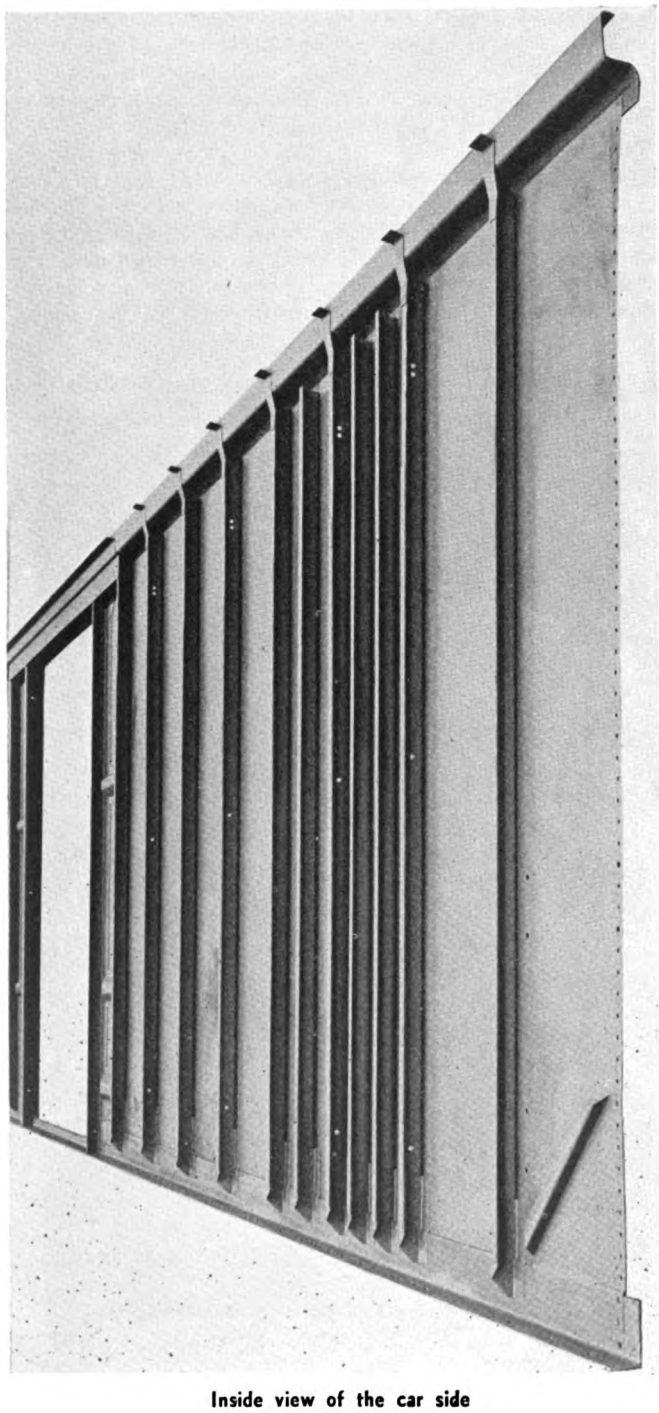
Side-plate, side-sill, side-post connections and gussets are applied to the assembled side sheets by means of portable spot welders at the next position.

The roof sheets are .05-in. high-tensile low-alloy steel with a Z-carline pressed integral and reinforced with a .05-in. pressed angle, spot-welded to each carline. The running-board saddle is spot-welded to the roof sheet and an automatic machine, similar to that employed in assembling the side sheets, is used to spot weld the roof-sheet sections together, using two rows of spots staggered, spaced 1 in. apart, with 1 in. between the rows.

Other assemblies include the spot-welding of door sheets, assembly of door sheets to door frame, arc-welding and riveting of door fixtures, etc.

Underframe Assembly in the Steel Shop

The underframe parts are assembled and united by arc welding in the steel shop where ample track facilities and equipment are available for the subsequent application of car sides, ends, roofs, etc.



Inside view of the car side

The center sills are A. A. R. Z-sections, reduced to $1\frac{1}{32}$ in., the two parts being joined by arc welding continuously at the junction of the top flanges. The cross-sectional area is slightly over 18 sq. in. total and is based on the use of high-carbon steel with a minimum yield point of 36,000 lb. per sq. in. and tensile strength of 60,000 to 72,000 lb. per sq. in.

I-section center-sill separators are located at cross ties and cross bearers. The draft sills are formed by the continuation of the center sills. The bolster center fillers, draft lugs and striker are built up integral with the center sills by arc welding of rolled bars. All parts of this construction are low-carbon open-hearth steel except the draft and buffing spacers, which are of high-tensile low-alloy steel.

The body bolsters are "bath-tub" type, $\frac{5}{16}$ in. thick, welded in one piece and reinforced where required. The body center plates are A. A. R. bowl type, welded to the underframe. The body side bearings are built up with $3\frac{1}{2}$-in. by $\frac{3}{8}$-in. wear plates.

The cross bearers, four per car, are built up I-sections with $\frac{1}{8}$-in. web and $4\frac{1}{2}$-in. by $\frac{1}{4}$-in. cover plates. The floor beams, two per car, are pressed in one piece, extending from center sill to side sill, being made of $\frac{1}{8}$-in. plate.

To provide bracing of the center sill to the car end, plates are welded to the center sill forming a T-section, which is welded completely throughout the width of the car to the end sheathing and at the corners to the side sills. Floor stringers, two per car, extend the full length of the underframe and are welded in place as shown in the illustration.

The various underframe parts are assembled upside-down in a special jig which holds them in accurate alinement while all underneath arc-welding operations are performed. The partially welded underframe is then turned over and all down welds made. The third operation is to place the underframe in a revolving jig which permits holding it in any position necessary for the completion of all underframe welding in the down-hand position.

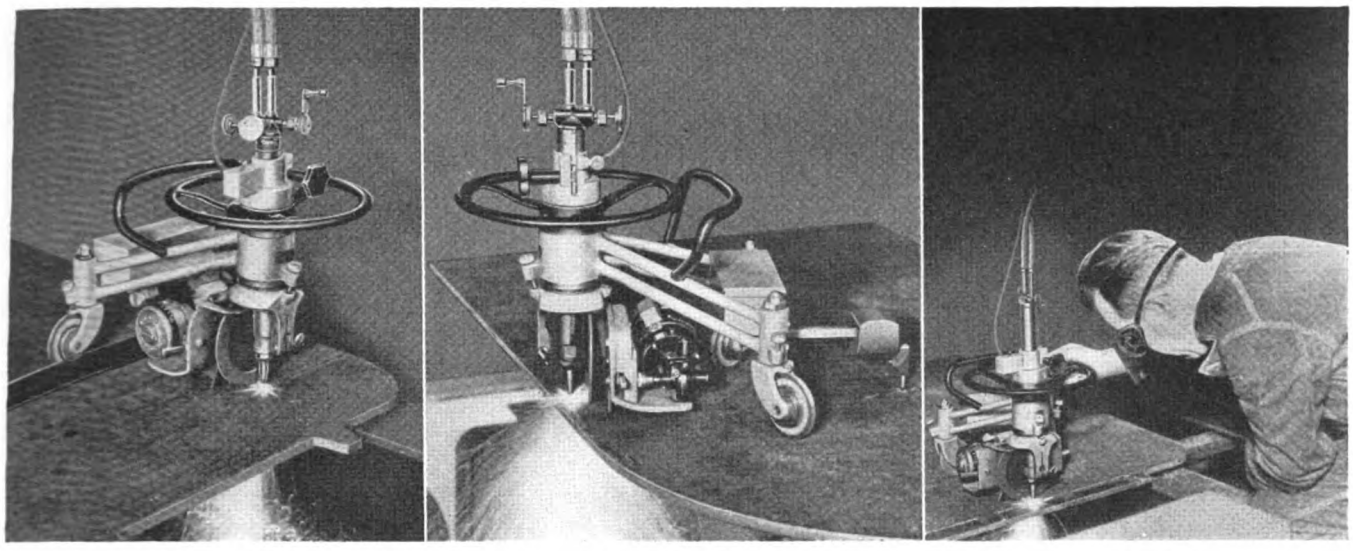
Finishing Operations

From the steel shop, the assembled car, including the underframe, car sides, two-piece pressed-steel ends, doors, etc., is moved to the wood erection shop where the inside wood lining and floor are applied, as well as the running board, safety appliances, etc. The car is then painted and stenciled.

Oxweld Portable Cutting Machine

The type CM-16 portable cutting machine illustrated, has been developed by the Oxweld Railroad Service Company, Chicago, Ill., for the shape cutting of steel parts. This machine is motor driven, compact, light, easy to manipulate and those engaged in railroad work find it useful in the shaping of steel plate, especially for car parts to be subsequently fabricated by welding.

For most work the machine can be set up and operated directly on the steel sheets without the use of a supporting table. When guided by hand, the CM-16 can be used for cutting irregular shapes to exact contour, and when used with a radius rod, the machine automatically cuts circles. It can also be operated on an angle-iron track for automatic straight-line cutting.



Oxweld Type CM-16 cutting machine operated (left) on an angle-iron track for straight cutting; (center) with a radius rod for circle cutting, and (right) hand-operated on an irregular contour

Its light weight, 45 lb. complete with blowpipe, permits the machine to be moved from job to job and operated with little more set-up time involved than in cutting with a hand blowpipe. It cuts to the edge of the plate and stops without running off the plate. Thus the machine requires a minimum of attention and permits the utilization of stock which would otherwise be wasted.

The Oxweld CM-16 cutting machine is driven by a 110-volt electric motor, the speed of which can be set by adjusting a direct-reading speed indicator to permit cutting from 4 in. to 30 in. per minute. The starting switch is conveniently located adjacent to the blowpipe valves. A clutch disengages the driving mechanism and allows the operator to free-wheel the machine across the work with the motor either running or shut off.

The CM-16 is equipped with a precision cutting blowpipe, Type C-12R. The cutting of bevels is readily accomplished by the use of a special attachment.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.A.R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Paint Loosening and Peeling From Interior of Passenger Car

On February 2, 1936, the Chicago & North Western delivered one of its modern chair cars to the Union Pacific at Omaha in good condition. On February 21 the car was received at Omaha with the interior finish badly damaged. It was cut out of service by the U. P. and returned to the C. & N. W. without the issuance of an A. A. R. defect card. The owner repaired the car and submitted a bill to the U. P. covering the total cost of repairs amounting to $888.30.

The owner pointed out that the car had been set out on the U. P. at Sidney, Neb., because of damage to the steam line caused by the train striking two cattle. The car was unheated for a period of 18 hours during which outside temperatures averaged 18 deg. below zero. It was then placed on steam after which the damage to the interior finish occurred. The car owner maintained that this consisted of improper handling, since excessive expansion and contraction of the steel caused thereby resulted in the damage in question.

The handling line pointed out that the C. & N. W. offered its passenger cars to the U. P. in through-line service subject to provisions of A. A. R. Interchange Rules and with full knowledge of the weather and operating conditions in the territory through which the cars operate and with the understanding that the owner will assume the cost of repairs either interior or exterior not classified as handling-line responsibility. The U. P. also pointed out that its own cars are subjected to similar treatment which the C. & N. W. contended was improper care.

In a decision rendered November 11, 1937, the Arbitration Committee stated: "Paint loosening and peeling from interior finish of passenger equipment cars under the circumstances in question, is a car owner's responsibility. The contention of car owner is not sustained."—*Case No. 1757, Chicago & North Western versus Union Pacific.*

Questions and Answers On the AB Brake

Brake Cylinders (Continued)

287—*Q.—What precaution must be taken when assembling the cylinder?* A.—It is necessary to make sure that no foreign matter is permitted to enter.

288—*Q.—When the service or emergency portion has been cleaned or repaired in the shop, what kind of a test should be made?* A.—Test should be made only on a standard test rack according to a code of test furnished with the rack.

289—*Q.—After the valves have been replaced on the car, is a test necessary?* A.—Yes. Test should be made with the use of a standard single-car test device.

290—*Q.—How much pressure should be used in the supply line?* A.—At least 70 lb.

291—*Q.—What should be done before attaching the*

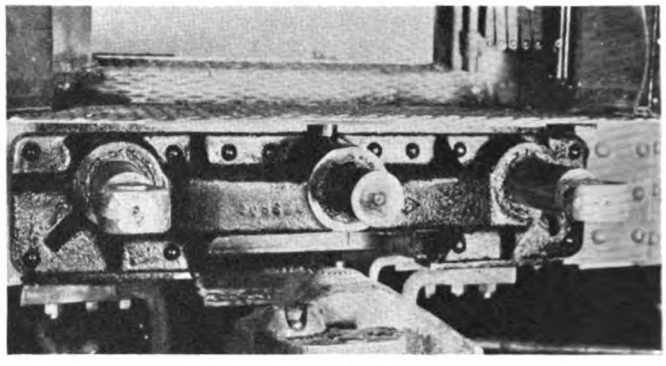
test device to the supply line? A.—The supply line should be blown out thoroughly in order to avoid the possibility of moisture and dirt getting into the test device or air lines.

292—*Q.—After the test device is connected to the air line at the supply end, what must be done before the other end of the device is connected to the brake pipe hose on the car?* A.—Move the device handle to lap position and open the cock in the supply line. There should be no escape of air from the device brake-pipe connection or its exhaust port.

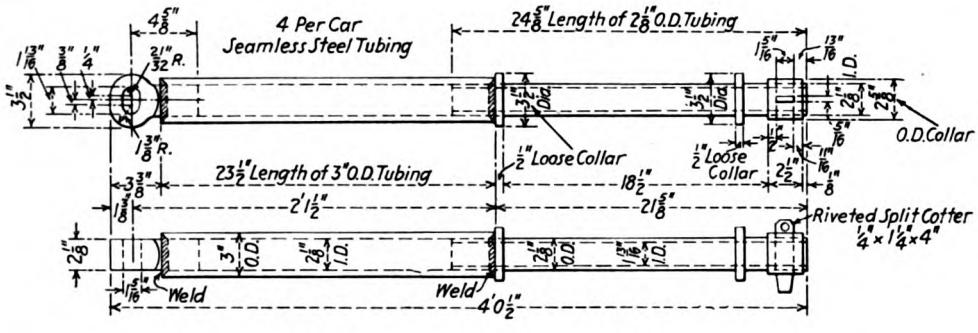
Passenger Car Buffer Stem Design

By Glenn L. Davis*

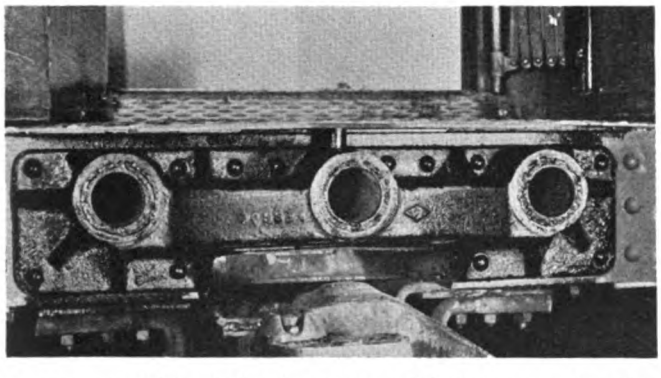
In recent years the elimination of noise in passenger cars has been the subject of much thought. Added insulation and the closing of cars incident to air conditioning have shut out much of the outside noise. Truck and buffer noises have, however, remained except where



The side and center buffer stems in place



Details of the side buffer stem



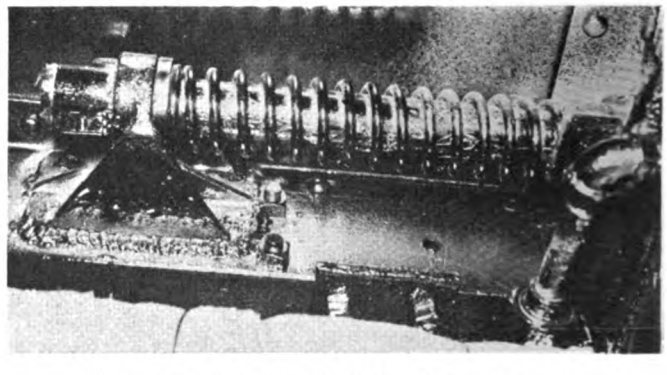
Passenger-car buffer designed to use round buffer stems of welded tubular steel construction

eliminated through design or the application of vibration-reducing, shock-absorbing material. One means of reducing buffer noise through design is described below.

The rectangular side and center buffer stems have been replaced with round stems fitting snugly in long Alemited bearings of steel tubing. Having only 1/32 in. clearance, the blows incident to the movement of the stems are very light. Having large projected area and being well lubricated they wear slowly and the maintenance costs are low.

Side stems are made of steel tubing for lightness and to reduce their cost. The smaller tube is inserted the correct distance into the large tube and welded. A forged-steel end, to which the diaphragm plate is attached, is provided with an oblong hole for the hinge pin. This hole is elongated sufficiently to provide the necessary clearances for curving. The stem is secured by means of a collar 2½ in. long, slipped over the inner end, both stem and collar being slotted for a ¼-in. by 1¼-in. by 4-in. riveted split cotter. The stem acts as a support for the buffer spring, which bears against two ½-in. loose washers. The inner end of the stem is supported in a steel casting provided with a liberal bearing which may be bushed with an insulating bushing or bored for the stem and lubricated.

The center stem is a 3-in. diameter round bar of proper length, operating in a long lubricated sleeve of steel tubing. Linoleum ⅛ in. thick encases the buffer and prevents it rubbing or striking the underframe.



Underneath view of a side buffer stem and spring

In order to minimize the side thrust on the buffer stems the diaphragm plate is lubricated with four Alemite fittings following the manufacturer's recommendations. Lubricating the diaphragm also reduces to some extent the noise of rubbing surfaces and lessens wear on the plates and the supports for the upper buffer mechanism.

* Drawing Room Supervisor, St. Louis-San Francisco, Springfield, Mo.

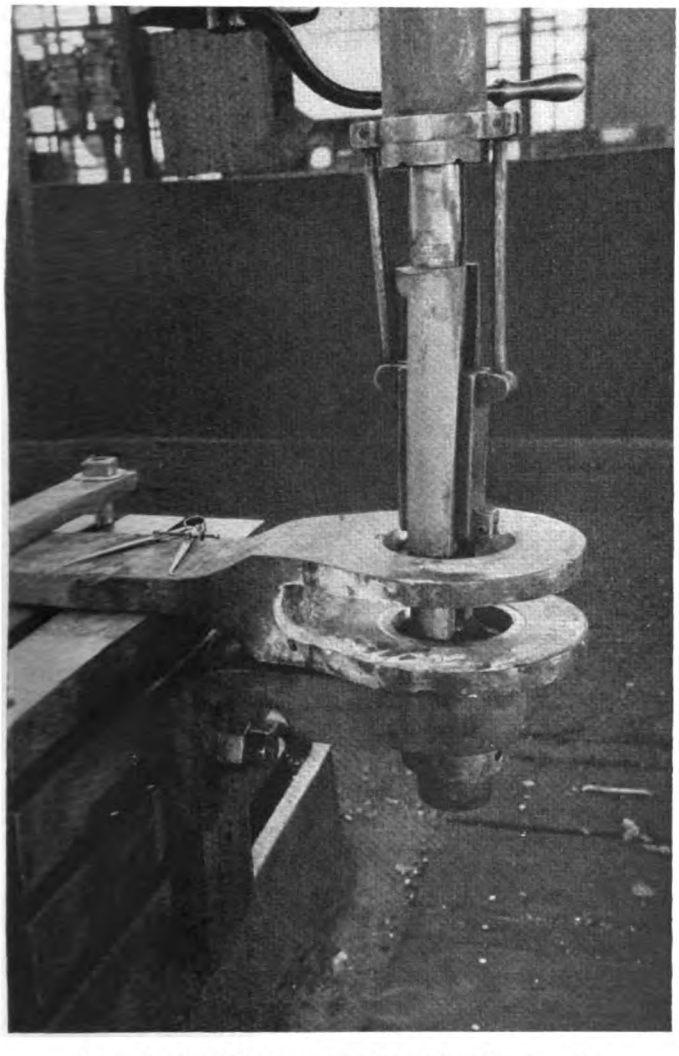
IN THE BACK SHOP AND ENGINEHOUSE

Taper Boring Bar Used With Drill Press

Side-rod knuckle-pin holes and crosshead wrist pin holes and piston-rod fits are bored at the Pen Argyle shops of the Lehigh & New England with the aid of a taper cutting boring bar on a drill press; the boring bar used for side-rod knuckle-pin holes is designed to cut a taper of 1½ in. per ft., while the boring bar used for the crosshead piston-rod fit is designed to cut a taper of ¾ in. per ft.

The boring bar has a No. 5 standard taper shank 9 in. long which fits the drill-press splindle. The boring-bar shank is bored to a diameter of 2 in. to receive the neck of the bar proper. The section of the boring bar below the neck is 3 in. in diameter and is milled with flat surfaces on opposite sides which are 15 in. long and has a taper of 1½ in. per ft.; the boring bar is slotted between the two tapered surfaces. Two 6-in by 1¾-in. by ½-in. slides are bolted together through the bar and attached by two ½-in. arms to the shank. One of the slides has a tool-holder lug for receiving the ⅜ in. tool bit which is held in place by a set screw.

When using the boring bar, the side rod is placed on the drill-press table and leveled. The boring bar is then set up as shown in the accompanying illustration. As the drill-press spindle revolves, turning the boring bar, the feed moves the drill-press spindle and the boring-bar shank downward. As the spindle and shank descend, the flat slides and the tool follow the taper on the bar, removing enough metal to clean up the knuckle-pin hole. This boring bar replaced the usual type of fluted reamer which chattered and placed a heavy power demand on the drill-press motor.



Boring bar for cutting tapered side-rod knuckle-pin holes

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

The Purpose of Air Ejectors on Centrifugal-Pump Suction Lines

Q.—What is the purpose of the air ejector on the feedwater-pump suction line of an engine equipped with a centrifugal water pump? How do you know if the ejector is functioning properly?

A.—Air ejectors are used on engines equipped with centrifugal feedwater pumps, when the pump is located ahead of the trailer truck and the pump-suction pipe is raised between the pump and the tank hose to clear the swing of the trailer-truck frame; the pipe is often raised to such a position that the high point in the pipe is above the level of the tank bottom. This raise in the suction line forms an air pocket in the pipe and the air ejector is applied to eliminate air from the suction line. If there were air in the suction line the pump would refuse to work. When air ejectors are omitted a vent pipe is applied, this vent pipe being run up to a height of eighteen inches above the top of the fender.

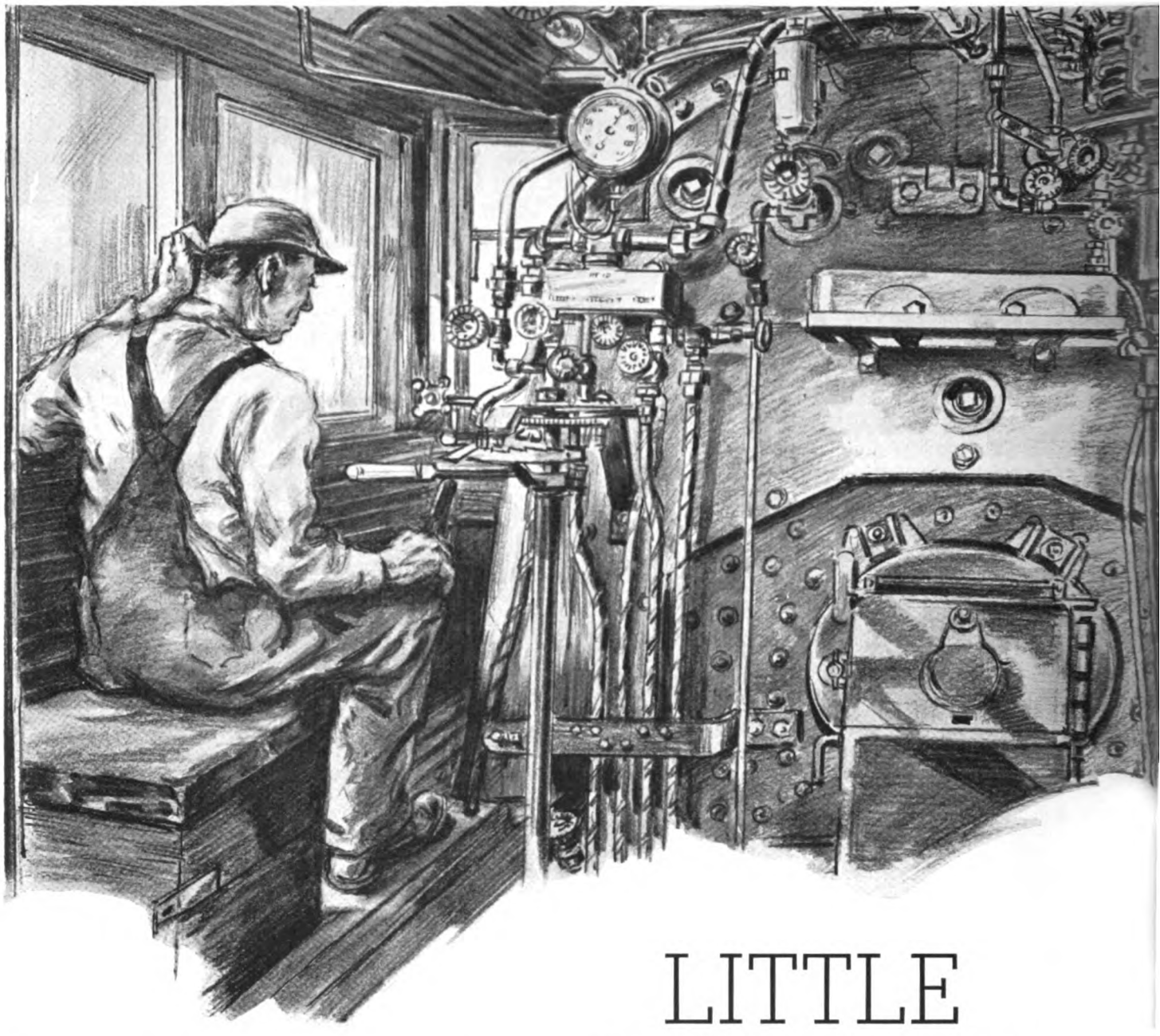
Air ejectors on feedwater-pump suction lines are tested by placing the hand on the high-pressure steam line to the ejector, the ejector, and the ejector discharge line; when the ejector is functioning properly, the steam line will be hot, the ejector will be cold and the discharge line will be warm.

How to Weld Flexible Staybolt Sleeves

Q.—What methods are employed in applying welded flexible staybolt sleeves?—F. C.

A.—The most common method of applying welded sleeves, is to drill and ream the hole in the wrapper sheet so that the sleeve penetrates the sheet ⅛ in. at the center. The sleeve is held tight against the counterbore in the sheet with an applicator and tack welded in

(Continued on page 197)



LITTLE TROUBLE

***by* Walt Wyre**

If Jim Evans was nervous and excitable he wouldn't have been roundhouse foreman at Plainville for the past sixteen years. He would have been wearing his hat crosswise and calling himself Napoleon or on another job long before now.

Evans learned long ago that in railroading what can't be cured must be endured, and a roundhouse foreman must do a lot of both. It's when something happens that should be corrected and no one seems able to find the remedy that makes a foreman wish he was back in overalls working eight hours a day.

Jim Evans doesn't get excited over trifles, but the 5077 came very near making an aspirin addict of the foreman and when the trouble was finally located it was so simple everybody concerned felt as foolish as a fat man who has sat down where he thought a chair was.

One morning about ten o'clock, the dispatcher called the roundhouse office. "The 5077 is falling down awful bad. Better look her over when she gets in, if she makes it," the dispatcher told Evans.

The engine came in over two hours late with seventy-two cars of perishables. Evans was waiting when the engineer ran the locomotive in on the lead. The hog-head climbed down from the cab and started around the engine.

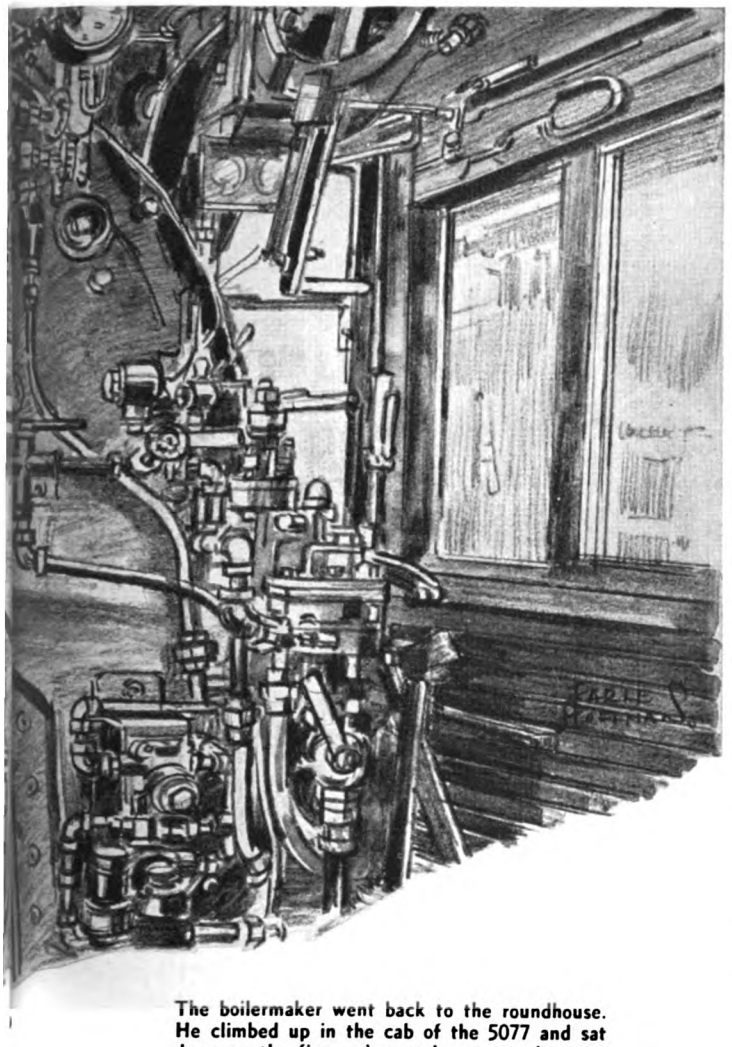
"How did she do? " Evans asked.

"Huh!" the engineer snorted. "It wouldn't pull a sick streetwalker out of a doorway!"

"Couldn't keep steam," the fireman chimed in as he shouldered his tin trunk and started towards the wash-room.

"I thought she was a pretty good engine," Evans said to the engineer.

"Yeah, may have been, but she's no good now," the engineer replied. "Acts like superheater units might be leaking," he added.



The boilermaker went back to the roundhouse. He climbed up in the cab of the 5077 and sat down on the fireman's seat box to ponder over the situation.

When the units were tested with water pressure, three of them showed slight leaks. The units were pulled out and repaired and the 5077 was marked up to run.

The locomotive went out Wednesday morning on No. 81, a fast merchandise train, and finished the run that same week after setting out part of the train. It came back with a light stock train, twenty-eight cars, and the engineer that brought her in said the engine did very well. A train of twenty-eight cars is one thing and one of ninety something else. Running time of forty-five miles an hour with ninety loads takes it out of a locomotive and one that is lacking just can't stand the racket.

"What seems to be ailing the 5077?" Evans asked the engineer that had her out of Plainville.

"Just won't cut the buck," the hogger answered. "Seems O. K. until you have to pour it on her, then she just quits, won't make steam. Could be the piston packing down," the engineer added. "Anyway, she uses steam faster than she makes it."

"Now that's a lot of help," Evans said aloud to no one in particular as he started to the roundhouse.

The foreman found Henry Barton, a boilermaker. Barton was in the fire-box of the 5091 calking a leak. The foreman stuck his head in the fire-box door and yelled to make himself heard above the reverberations of sound in the spacious fire-box. "Say, Barton, did you look over the 5077 before it went out last trip?"

The boilermaker scratched his head and squinted one eye like a man aiming a gun. "Yes, believe I did. Yeah, that's right, I know I did now."

"How did you find her?"

"Oh, not so bad; the channel was pretty well clogged with carbon. My helper cleaned it out, though."

"Did you notice anything else that might keep the engine from steaming?"

"No, nothing except possibly the diaphragm plate is going to have to be renewed soon."

"Was it leaking?" Evans asked.

"Not while standing still," the boiler maker replied, "but I noticed several places that showed it had been leaking. You see, when a locomotive gets to twisting and weaving like they do when they are running, a crack in the diaphragm plate that you wouldn't hardly notice when the engine is standing still sometimes opens up and leaks quite a bit. If you don't mind coming in the fire-box, I'll show you one on this one."

Evans would have climbed stairs to the top of the Empire State building to find a clue to the trouble with the 5077. He wriggled feet first through the fire-box door and followed Barton to the front end of the fire-box.

"See?" The boilermaker held an extension light with one hand and pointed to an irregular white line on the diaphragm plate.

Evans from habit pulled a flashlight from his pocket and directed the beam on the plate where the siphon neck enters the throat sheet. "So that's what you call the diaphragm plate?"

"Yeah, I don't know whether that's the correct name or not, but it's all I ever heard one called except the store department calls them siphon patches. I suppose the reason for calling them 'diaphragm plates' is they are corrugated so they will expand and contract like a diaphragm."

"Don't look like that would give much trouble," Evans said.

"Well, it may not," Barton replied, "but it don't take much leak in this type of fire-box that has a fairly large combustion chamber in the barrel of the boiler to affect steaming."

"Can't you weld the cracks?" the foreman wanted to know.

"Not to do much good. When a diaphragm plate gets checked all over with hairline cracks, the best thing to do is put in a new one."

"Maybe that's what's the matter with the 5077," Evans said hopefully.

"Might be," Barton agreed.

"Let's look at it when it gets cold," Evans suggested as he pocketed his flashlight and started away.

TROUBLE, according to the old adage, never comes single. On the railroad, and particularly in a roundhouse, it seems to come in flocks and breed like guinea pigs.

The 5091 on her last trip in had been reported foaming badly. The boiler needed washing badly, no argument about that, even before the water was tested. The drip from the blow-off cocks looked like whitewash. On short time for a locomotive and with nothing else available, Evans told them to give the 5091 a change of water, some extra compound, and run her.

She came in just ahead of the 5077. The engineer reported that the engine had fallen down badly all the way from Sanford. "The boiler is dirty as a Mae West joke and she hasn't got as much power as a Jewish politician in Germany," the engineer told Evans. "I believe the piston packing is down."

The hoghead was right on all counts. When the en-

gine was in the house, the foreman left orders to have the boiler washed and told a machinist to pull both pistons and examine the packing.

The packing was cut out and the right cylinder was scored a little. Water sloshing over from the foaming boiler had flushed out the lubrication and metal to metal friction did the rest.

In the meantime, the 5077 had been run in the house and blown down. Evans was examining the scored cylinder when Barton came by. "I was going down to look at the diaphragm plate on the 5077," the boilermaker said. "Would you like to take a look at it?"

The two climbed up in the cab and into the fire-box. "The brick look pretty good," Barton commented, playing the beams of his flashlight around the interior of the fire-box.

"Yeah, not bad," Evans said. "Have you looked at the burner?"

Both men, flashlights in hand, walked to the front of the fire-box and stooped to examine the burner.

"Not bad," Barton commented as he stooped lower for a better look. "The atomizer slot is worn a little, but not enough to cause trouble." The boilermaker held the flashlight closer and played the spot of the light beam over the burner.

"Thought maybe it might be cracked on the side," Barton said. "That sometimes causes trouble with an engine steaming."

"Is it cracked?" the foreman asked, hoping to find what defect was causing lack of power in the locomotive.

"No," Barton replied, straightening up, "looks O. K. to me."

"Well, let's look at the diaphragm plate," Evans said resignedly.

"Leaking a little here." Barton traced a white crack with a pointing forefinger.

"And here." Evans found another place.

"What do you think?" Evans asked when he and Barton had finished examining the diaphragm plate.

"Well," Barton said thoughtfully, "it's not bad. I doubt if it's causing the trouble. On the other hand, then it could be. Like I told you, when an engine gets to hittin' the high spots and twistin' all over like a fat girl doin' the Big Apple, it's hard to say just what does happen. But still I don't think that's the trouble with this engine."

"Well, something's wrong and we've got to find out what it is." Evans shoved his hat back on his head and scratched thoughtfully.

"I can put in a new diaphragm plate if you say so," Barton prompted.

"All right, let's put it in and go over everything that might be causing the trouble." Evans climbed out of the fire-box and started to the office.

HE DIDN'T go to the office, though, at least not just then. What changed his mind was he saw the switch engine coming towards the roundhouse. Coupled to the goat was a shiny, newly painted locomotive.

Evans knew before he saw the numbers it was the 2735 out of the back-shop. He was so glad to see the locomotive he could have kissed it. The foreman waited until the 2735 was shoved in on the inspection track and walked out to look it over.

The hostler slid from the cab on an engine nearby and joined the foreman. "She's got new drivers," the hostler noted, pointing at the disc drivers on the locomotive.

"Yes, and they put on a feed water pump and heater," Evans said.

The foreman walked around the locomotive and climbed up in the cab. The hostler followed him slowly.

"Ought to be a good engine now," the hostler said.

"Yeah," Evans agreed, "she's been overhauled from pilot to draw-bar and partly rebuilt. Let's get her shoved in the house and get the rods on. If anybody ever needed a good engine, I need one now."

The 2735 was ready to go next morning. They ran her on the west local to break her in. The road foreman rode the engine and when he came back on her next day reported a good trip.

"How did she steam " Evans asked.

"Seemed to do all right," the road foreman said. "Of course, we just had a light train and weren't trying to break any speed records."

Next day when the dispatcher asked for a locomotive for a west bound drag, Evans gave him the 2735.

About three o'clock in the afternoon the dispatcher called the roundhouse office and asked to speak to Evans.

"Say, what's the matter with all your engines lately? That 2735 on the drag is getting along so slow that hoboes are getting off and walking!"

"Should be a good engine," Evans replied. "Right out of the back shop."

"Well, it acts like it shouldn't have left there," the dispatcher said.

"Maybe it's still a little tight and will do better when it's limbered up," Evans said.

"Hope so," the dispatcher commented, and hung up.

"How's the 5077 coming?" Evans asked Barton the next day after the engine had been tied up for a diaphragm plate.

"Get her finished sometime tomorrow if nothing happens," the boilermaker said.

"Look her over good before she goes out."

"O. K.," the boilermaker replied.

The 2735 did no better on the inbound trip than she had going west. Boxes and pins ran cool, but that was, the engineer explained, because the engine wouldn't pull the train fast enough to run hot. "Just won't steam," the engineer said.

Fortunately for the foreman's peace of mind, the trouble with the 2735 was located with less trouble than he was having with the 5077.

The boilermaker examined everything in the fire-box, then opened the front end. Evans climbed up on the pilot and looked in.

Barton had only been in the smoke box a couple of minutes when he said, "I believe here's the trouble!"

"What is it?" Evans asked.

"Whoever set that feed water heater on top of the smoke box didn't do a very good job. Too much air leak around it."

Evans pulled himself up through the front end door and looked.

The feed water heater was set on top of the smoke box with the lower side of the drum in an opening cut in the top of the smoke box. Whoever did the job in the back shop had evidently been in a hurry, because the drum didn't fit tight in the opening.

"Looks like that might be the trouble," Evans agreed.

"Yeah, that much air getting in would keep it from steaming," the boilermaker said.

The leaks around the feed water heater were repaired and the engine dispatched that night.

Next morning Evans was almost afraid to look at his mail for fear the 2735 had died some place, but there was no wire or traingram about the engine.

Evans, to satisfy his mind, called the dispatcher and asked how the 2735 had done.

"Run like a striped tail ape," the dispatcher said.

Evans was somewhat relieved, but there was still an-

other load on his mind. The 5077 was still in the house. The engine was finished and the foreman was almost afraid to run her.

After the 8:00 whistle blew, Evans found Barton. "What do you think about the 5077?"

"Well, as far as the boiler work is concerned, she looks like a good engine to me."

"How's the front end?" Evans remembered the trouble with the 2735.

"O. K.," Barton replied, "I looked it all over yesterday. There's not any leaks around the nozzle stand. The petticoat pipe is in good shape, right in the center and no holes in it. In fact, everything in the front end looked O. K. to me."

"How's the steam nozzle? Did you measure it?"

"Yeah, it's standard, the same as all the 5000's."

"Well, I guess she should be ready to run. Have a fire put in her." The foreman marked the 5077 up ready to run.

The dispatcher called for an engine to run east on No. 82 at 1:15. Evans gave him the 5077.

It was just another chapter of the same old story. The 5077 just wouldn't do her stuff. The train lost time all the way to Sanford.

WHEN the phone rang about four o'clock, Evans had a premonition, only he called it a hunch, that the 5077 wasn't doing so well. "Say, if all the engines were like the 5077, we could throw away our watches and run trains by the calendar," the dispatcher said sarcastically.

"Not doing so good?" Evans asked.

"Going to have to cut her out at Sanford," the dispatcher said accusingly.

When the 5077 came in on the local the next day, Evans shuddered at the sight of the big locomotive. He resolved then and there to not run the engine again until the trouble was corrected.

The rapidly accumulating file of letters, traingrams, and wires about the engine were enough to remind him in case he forgot.

He called Barton to the office. "I want you to find out what's wrong with the 5077," Evans told the boilermaker. "From what the engineers say, the trouble is it's just not steaming. I've examined pistons and valves. They're in good shape. We tested the units and dry pipe, so it must be combustion. I want you to stay with it until you find the trouble."

The boilermaker went back to the roundhouse. He climbed up in the cab of the 5077 and sat down on the fireman's seat box to ponder over the situation.

Barton was confident that none of the usual troubles was causing the 5077 to not steam. But what was it? As he sat thinking he moved the handle of the firing valve back and forth.

Just before noon the dispatcher called the roundhouse office. "I want an engine for a special at 3:15, a good engine," the dispatcher added.

"What kind of special?" Evans asked.

"Race horses from California. They were going another route and changed to the S. P. & W. The owners are with them and in a hurry. It'll take a 5000."

"I'll call you back," Evans groaned. There wasn't a good 5000 in the house. The only one that should be in condition to go was the 5077.

He decided to look them over, even though he knew the condition of every locomotive in the roundhouse. When the foreman reached the 5077 there was no one around the engine. He went in search of Barton.

"What's the matter? Did you give up on the 5077?" he asked the boilermaker.

"No—finished."

"Hope so," Evans commented fervently. "I've got to have an engine that's in good shape."

"Take the 5077," Barton suggested.

"Reckon it'll run? What did you find?"

"I think it will go. If you don't mind, I'll tell you what I found after it makes a trip."

"I haven't got time for riddles," Evans said, "but I'm going to run the 5077 on a hot-shot special. It had better go!"

About five o'clock, Evans called the dispatcher and asked how the 5077 was doing.

"Running like a bat out of hell!" the dispatcher said.

Evans went to the roundhouse and found Barton. "What did you do to the 5077? She runs like a new engine."

"Well, after looking over all the big things I decided to look at the little ones. The handle on the firing valve had slipped on the shaft and it didn't open the oil valve wide open. I don't see why some one didn't notice it before," Barton added.

"Neither do I. It would have saved me a lot of trouble if they had."

Locomotive Boiler Questions and Answers

(*Continued from page 193*)

place. The applicator is then removed and the sleeve welded all around.

The applicator is made of a round bar of suitable length and threaded at one end to suit the tapped staybolt hole in the crown sheet. A handle is secured to the opposite end for engaging the applicator in the crown sheet and a washer, the outside diameter of which is threaded to engage the staybolt-cap threads of the sleeve, is free to move along the applicator. The body of the applicator is threaded and a hand screw is applied thereon. The use of the sleeve applicator assures the correct alinement of the sleeve and bolt and at the same time holds the sleeve securely in the counterbored seat in the plate.

Sleeves are also applied without the use of an applicator by applying the bolt and sleeve together, drawing the bolt down in the sleeve; the bolt holds the sleeve in the counterbored seat in the wrapper sheet. With this method all bolts and sleeves are applied, the face of the sleeves lined up with the wrapper sheet and the sleeves then welded all around.

How Do Steam Dryers Function And Why Are They Used?

Q.—Why are steam dryers used on locomotive boilers and how do they function?—B. J. B.

A.—Steam dryers are used on locomotive boilers to separate the water from the steam before it passes to the superheater. Due to the high water level carried on modern boilers, which generally have low domes, the steam is saturated with water when passing into the bootleg or dome throttle. Tests have shown that for each per cent of water, by weight, that is carried over into the superheater with the steam, there is a drop of about 17 deg. in superheater. In large locomotives the carry-over of moisture into the superheater is from 5 to 10 per cent.

The steam dryer is usually located in the dome and takes the place of the conventional bootleg at the end of the dry pipe. Some types of dryers are incorporated

as part of the throttle valve. There are various makes of steam dryers on the market, each using its own principle of removing the water from the steam. One method is to enter the steam into the dryer, which consists of fixed turbine-shaped vanes arranged within the body of the dryer, causing the entering steam to be whirled around at high velocity with the result that the water is centrifugally separated against the sides, ejected through the outlets, and returned to the boiler.

Another method is to enter the steam into the dryer through circumferential radial slots in the outer wall of a cylindrical shape dryer, the slots being so shaped as to divert the direction of the steam. The steam is then passed through another series of radial slots in a second cylindrical wall, abruptly changing the direction of the steam flow; the steam then passes into a third chamber through protruding cone-shaped nozzles in the outside wall of the inside chamber. These successive actions produce powerful tangential and turbulent impact and inertia effects that separate the water from the steam.

When to Test Staybolts

Q.—Should the staybolts of a locomotive boiler be hammer tested when the boiler is empty or when under pressure?—H. V. D.

A.—Either method is acceptable; however, there are certain circumstances which determine whether the test shall be made with the boiler under pressure or with the boiler empty.

The Master Boiler Makers' Association recommends that it is practical to hammer test staybolts while the boiler is under hydrostatic or air pressure. However, this cannot be successfully done at monthly inspections in enginehouses or when the engine is undergoing classified repairs; therefore, it is recommended that staybolts be hammer tested under these conditions with the boiler empty. In the enginehouse, the test should be made just as soon as the boiler is empty of the hot water and while the firebox is somewhat expanded. In the backshop, when the engine is undergoing classified repairs, the staybolts should be hammer tested and inspected from the interior of the boiler, and all defective bolts renewed, when repairs to the boiler are completed and hydrostatic pressure applied. All staybolts should be hammer tested again while the boiler is under pressure.

Provisions for staybolt testing, as given in the I. C. C. laws, rules and instructions for inspection and testing of steam locomotives and tenders and their appurtenances, are as follows:

"21. Time of testing rigid bolts—All staybolts shall be tested at least once each month. Staybolts shall also be tested immediately after every hydrostatic test.

"22. Method of testing rigid bolts—The inspector must tap each bolt and determine the broken bolts from the sound or the vibration of the sheet. If staybolt tests are made when the boiler is filled with water, there must be not less than 50 lb. pressure on the boiler. Should the boiler not be under pressure, the test may be made after draining all the water from the boiler, in which case the vibration of the sheet will indicate any unsoundness. The latter test is preferable.

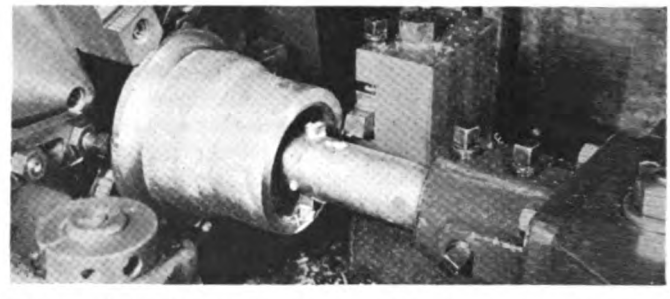
"23. Method of testing flexible staybolts with caps—Except as provided in paragraph (b) all staybolts having caps over the outer ends, shall have the caps removed at least once every two years and the bolts and sleeves examined for breakage. Each time the hydrostatic test is applied the hammer test required by rules 21 and 22 shall be made while the boiler is under hydrostatic pressure not less than the allowed working pressure.

"(b) When all flexible staybolts with which any boiler is equipped are provided with a telltale hole not less than $\frac{3}{16}$ in. nor more than $\frac{7}{32}$ in. in diameter, extending the entire length of the bolt and into the head not less than one-third of its diameter, and these holes are protected from becoming closed by rust and corrosion by copper plating or other approved method, and are opened and tested each time the hydrostatic test is applied, with an electrical or other instrument approved by the Bureau of Locomotive Inspection, that will positively indicate when the telltale holes are open their entire length, the caps will not be required to be removed. When this test is completed, the hydrostatic test must be applied and all staybolts removed which show leakage through the telltale hole.

"The inner ends of the telltale holes must be kept closed with a fire-proof porous material that will exclude foreign matter and permit leakage of steam or water, if the bolt is broken or fractured, into the telltale hole. When this test is completed the ends of the telltale holes shall be closed with material of different color than that removed and a record kept of colors used."

Cobalt-Chromium-Tungsten Alloy Cutting Tools

Haynes Stellite Company, Kokomo, Ind., is now offering a cobalt-chromium-tungsten alloy for metal-cutting tools. The alloy, which is known as Haynes Stellite-2400, was designed to provide greater edge strength, operate with economical tool life at even higher speeds than Haynes Stellite J-metal, with no reduction of feeds and depths of cut. These alloy cutting tools are marketed in a variety of sizes of solid square and rectangular tool

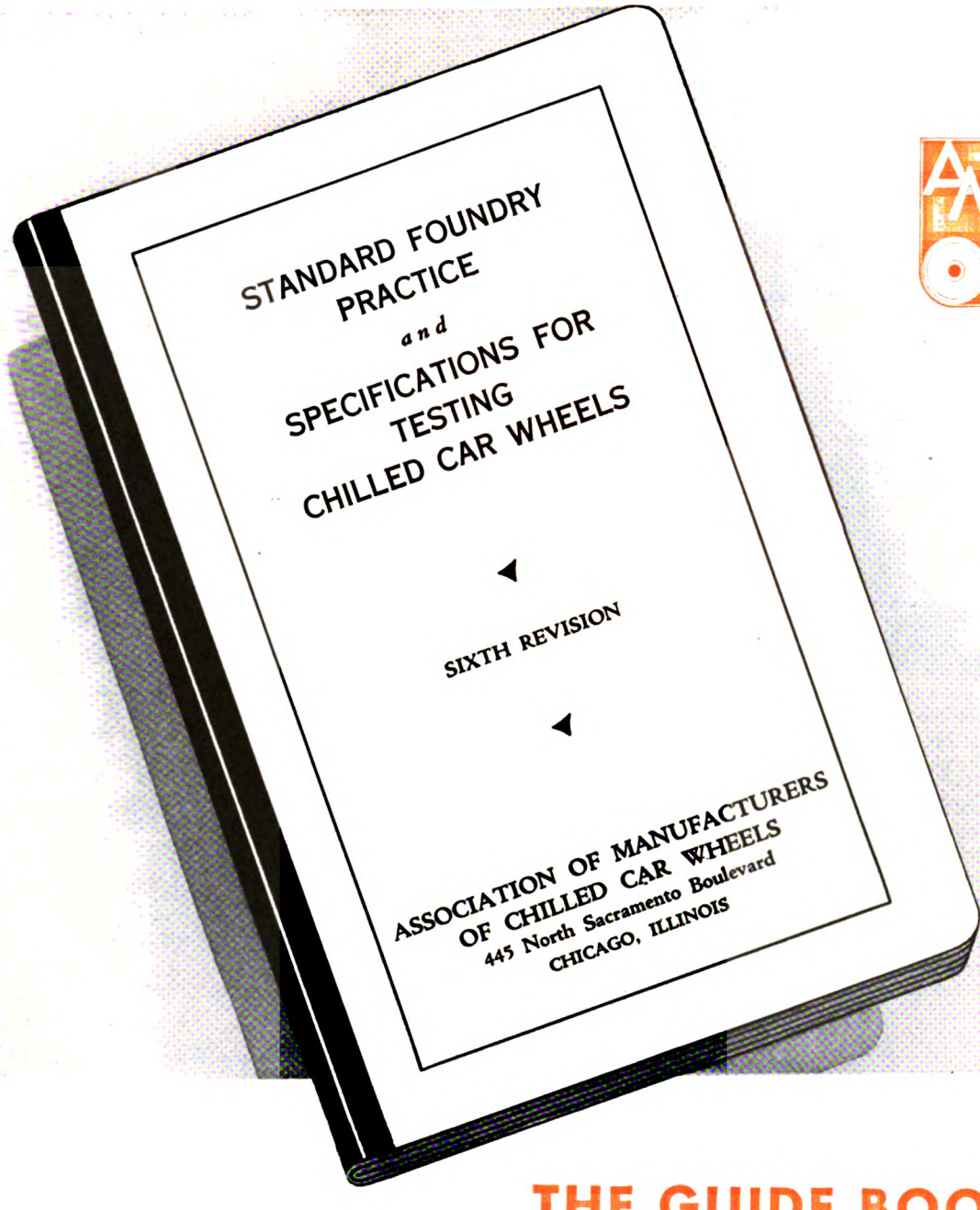


Rough and finish facing, and boring high-chromium steel with a Haynes Stellite-2400 tool bit

bits, welded-tip tools, milling cutter blades, and special small tools to suit requirements. This alloy is said to have shown marked superiority over tools previously used, including J-metal, and has proved suitable and economical for roughing and finishing cast and forged steels; nitrided, stainless, and other alloy steels; cast iron and malleable iron. Speeds and feeds recommended for its use are from 10 to 50 per cent in excess of those at which J-metal is now being operated.

Haynes Stellite-2400 can be ground either by hand or by machine. While cutting, edges should be supported as much as possible, depending upon the operation. The strength of the alloy is such that, in some cases, allowable clearance angles are as great as those used with high-speed steel tools. It is not possible to give definite cutting or clearance angles, as every job must be treated individually to determine the best operating conditions.

(*Turn to next left-hand page*)



THE GUIDE BOOK of an INDUSTRY

The fundamental basis of any properly organized inspection system is a standard set of stringent manufacturing specifications carefully covering the processes of manufacture, fixing definite limitations and tolerances and requiring instrumental control and tests necessary to prove the required quality of the product.

The A. M. C. C. W. specifications are so written. Furthermore, they are always subject to revision and further restrictions as new and improved processes are developed by our well-organized RESEARCH DEPARTMENT in the course of our efforts to make "Every Wheel As Good As The Best."

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High Spots in
Railway Affairs . . .

Railroad Leader Retires

A rugged and colorful personality retired from railroad service on March 31, when Leonor F. Loree, president of the Delaware & Hudson for very nearly 31 years, resigned because of failing health as he neared his eightieth birthday. A thinker, a fighter, and thoroughly experienced in practical railroading, he made an unusually large contribution to economic progress. Trained as a civil engineer he slipped over into the operating department in which he advanced rapidly. President for three years of the Baltimore & Ohio, and then of the Rock Island Company, he became president of the D. & H. in 1907. Almost coincidentally with his long D. & H. service, he was chairman of the Kansas City Southern. Railroad mechanical men appreciate his keen understanding of their technical problems. Under his sponsorship the D. & H. has led the field in experimentation with high steam pressures locomotive boilers. Greatly interested in the simplification of locomotive and car design, he could tell the exact number of parts in the latest D. & H. equipment. Regarded by some as an opponent of organized labor, he went far beyond most railroad officers in attempting to insure continuity of employment and social security.

Train Limit Bill Buried

On March 31 the House Committee on Interstate and Foreign Commerce, after long and extensive hearings, voted 14 to 7 against reporting the bill to limit freight trains to 70 cars. It will be recalled that the railroad world rubbed its eyes in amazement on July 26, 1937, when the United States Senate, without having held any hearings by its Interstate Commerce Committee, unexpectedly passed the bill without a record vote. In the hearings recently held by the House Committee, railroad labor representatives argued that the shorter trains could be operated with greater safety and would develop more traffic; they soft pedaled on the "make work" argument. Railroad managements, on the other hand, insisted that fewer trains of longer length could be operated with greater safety and far more economically. Reduction to a maximum of 70 cars would demoralize freight traffic and increase the annual operating costs by $100,000,000 and would require additional capital expenditures of one-half billion dollars for rearrangement of facilities. Moreover, several billions of dollars invested in recent years to make possible the safe and expeditious handling of the longer trains, would be practically wasted.

I. C. C. In Wrong Again

Continued poor business conditions and the resulting low freight car loadings, on top of the action of the Interstate Commerce Commission in granting only a small part of the freight rate increase requested, have placed the railroads in a most hazardous position. Denial of the passenger fare increase on the eastern railroads has not simplified the situation. The Interstate Commerce Commission is being widely criticized for overstepping its bounds and usurping managerial functions; indeed, this was even emphasized in one of the dissenting opinions of an Interstate Commerce Commissioner in the eastern passenger rate decision. President Roosevelt himself, in his message to Congress, suggested that the Interstate Commerce Commission's "purely executive" powers "are in all probability unconstitutional." "It would seem," he said, "to be part of common sense to place all executive functions relating to all transportation in one federal department—such as the Department of Commerce, the Department of the Interior, or some other old or new department. At the same time all quasi-judicial and quasi-legislative matters relating to all transportation could properly be placed under an independent commission—a reorganized I. C. C. And such action would be highly constitutional."

The President Side Steps

Considering the widespread publicity given to the fact that the President was holding conferences on the railroad question with various interested parties, and the fact that a railroad committee, consisting of Interstate Commerce Commission Chairman Splawn and Commissioners Eastman and Mahaffie, rushed their report to him at Warm Springs, considerable surprise was expressed at the fact that he merely bundled up the committee's report with various comments from different people and passed it on to Congress on April 11, with no recommendations and a statement that, "Until it has been possible for the Congress to make any and all studies for a permanent solution of the railroad problem, some immediate legislation is, I believe, necessary at this session, in order to prevent serious financial and operating difficulties between now and the convening of the next Congress."

Must Face the Music

Critics have accused railway officials of whining when they have pleaded their case for relief from unfair competitive conditions and regulation. The Administration and Congress have had so many other pressing problems on their hands that they have practically marked time in considering the railroad situation, or, as in the case of the Interstate Commerce Commission, have turned a deaf ear to the necessities of the carriers. The "recession," however, has put the "fat in the fire" and something must be done! What it will be is not apparent as we go to press. The Congressional leaders are calling conferences and the railway executives are very much on the jump trying to find solutions to take care of the immediate necessities. Any long time measures are so controversial that only slow progress may be expected, with all the other troubles in which the nation finds itself. Such immediate remedial suggestions as have thus far been made by those in high governmental and political positions are picayune. They must "face the music," however, and action must be taken without delay if anything is to be done by the present Congress.

Concerning Wages

Following a conference between railway executives and labor leaders after the President sent his message on the railroad emergency to Congress, George M. Harrison, president of the Railway Labor Executives Association, stated: "The carriers asked us to discuss a wage reduction and we replied, 'Hell, you are not going to get anything out of us'. We won't give them the whiskers from yesterday's shave." J. J. Pelley, president of the Association of American Railroads, after the refusal of the labor leaders to consider a voluntary wage cut said, "There is just one thing about it. We have got to have more for what we do and pay less for what is done for us. A reduction of wages is necessary. If the labor unions would talk about a voluntary reduction it would only be until times get better. If we are forced to use the Labor Act machinery, we will formally request a reduction." What would the public think, if in the argument on wages, the actual facts were blazoned forth as to the gross injustice to the railroads and the public of some of the wage rules of the engine and train service employees? Is there any better time for a frank discussion of these facts?

(Turn to next left-hand page)

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NEWS

Equipment Repair Programs

The Chicago Great Western has placed an order with the Pullman-Standard Car Manufacturing Company for repairs to 27 box and automobile cars.

The Lehigh Valley has received permission from the Interstate Commerce Commission to borrow $778,000 for repairs to equipment, including 1,460 steel coal cars.

Shop Improvements

Chicago & North Western.—The Chicago & North Western will restore its shops at South Pekin, Ill., which were destroyed by the tornado that swept through this vicinity on March 30. Damage to the shops and other property of the railroad is estimated at $100,000.

Western Pacific.—A contract for the construction of an extension to this company's locomotive repair shop at its general shops at Sacramento, Cal., has been awarded to Fred J. Early, Jr., San Francisco, Cal. The new building, of steel and concrete, will be 150 ft. by 300 ft., and is part of a project for the improvement of the general shops which calls for an expenditure this year of approximately $460,000.

Century Schedule to be Reduced One-Half Hour

A REDUCTION of 30 min. in the schedule of the Twentieth Century Limited of the New York Central, operating between Chicago and New York, will be made on June 15, when new streamline steam-operated trains will be placed in service.

Because the new Century, an all-room train, will carry no Boston service, a new train, to be known as the "New England States" will be inaugurated between Chicago & Boston on June 15. It will be an all-Pullman train of standard Pullman equipment with sections, bedrooms, compartments, drawing-rooms and lounge facilities.

Testing Laboratory Named After Prof. Talbot

ON April 21 the Materials Testing Laboratory at the University of Illinois, Urbana, Ill., became known as the Arthur Newell Talbot Laboratory, in honor of Arthur N. Talbot, professor emeritus of the university, who is widely known in the railroad field for his investigations of various railroad engineering problems, particularly stresses in track. This new honor was conferred on Prof. Talbot "for those brilliantly active years as a teacher and investigator which have contributed so much to the University of Illinois and to the engineering profession."

"Men Make Steel"

A NEW four-reel film of steel making, in technicolor and sound, was shown at a preview at the Waldorf-Astoria Hotel, New York, on April 13 by the United States Steel Corporation. It is entitled "Steel—Man's Servant." The color film, which strikingly brings out the spectacular quality of steel-mill operations, carries the story from the open-pit mines on the Missabe Range, down the Great Lakes to the ore-unloading docks, and thence through the operations of steel making and the production of the various finished products of the industry. A one-reel version in technicolor was also shown at the preview. This carries the audience over the same ground as the longer film, but with the pictures confined to the more dramatic phases of the operations. Both films deal with the human factor in the making of steel as well as with the spectacular mechanical operations.

The films were produced by Roland Reed Productions which maintained a movie crew of 21 photographers, technicians and electricians on location for a 10-weeks' period. The R. C. A. sound system was used. The story accompanying the pictures is told by Edwin C. Hill. The musical score was recorded under the direction of Robert Armbruster, Vittorio Giannini being the musical consultant.

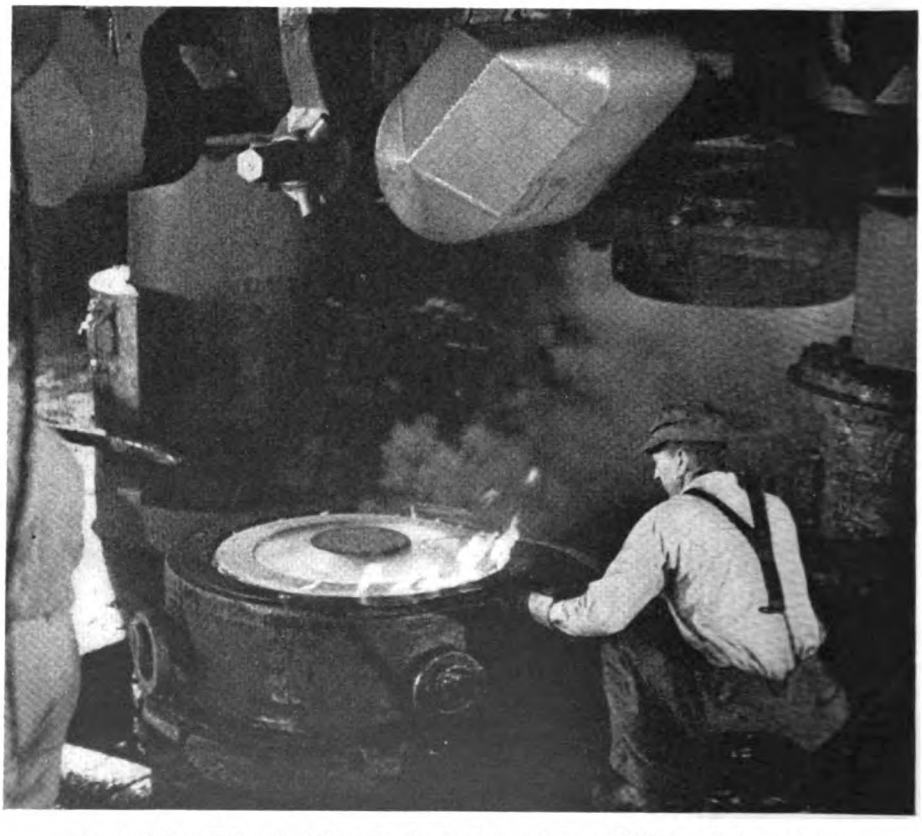
Both films are intended for educational and entertainment purposes. A considerable demand for the longer film has already developed in the moving picture houses of steel-mill towns. The United States Steel Corporation has also produced 16 mm. black-and-white films which deal at greater length with the technique of the various operations. These are intended for use in schools and colleges.

Broadway, Carrying New Cars, to Make Sixteen-Hour Run

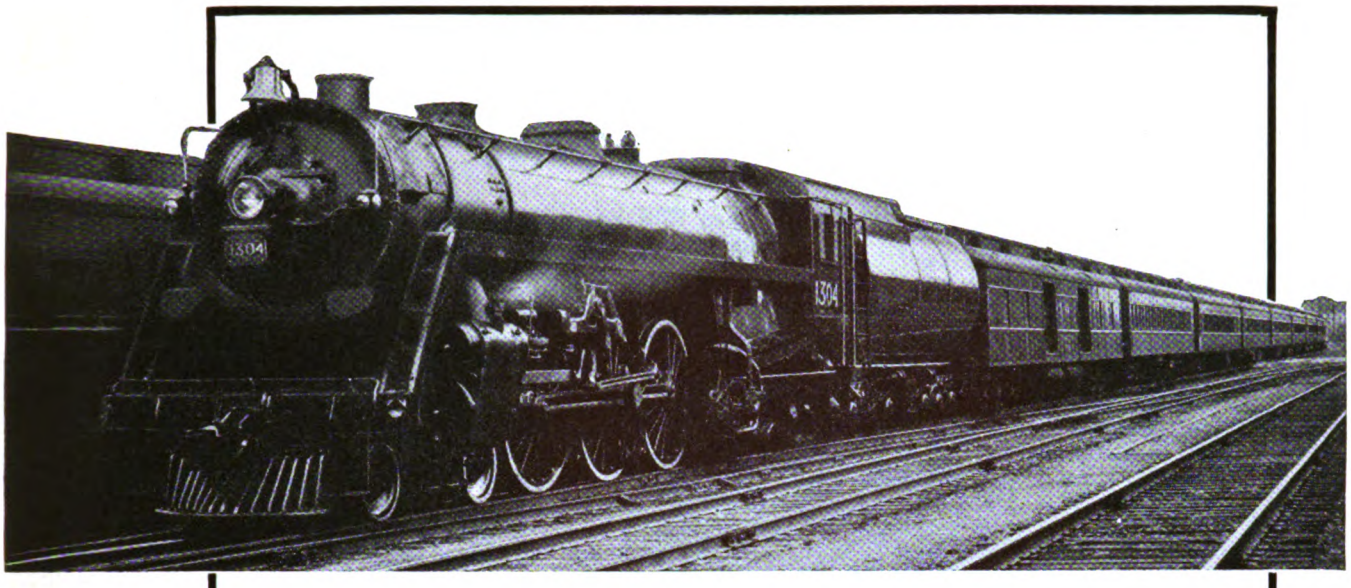
THE Pennsylvania's Broadway Limited, carrying new equipment, will run between New York and Chicago in 16 hours, effective June 15, reducing the New York-Chicago schedule by 30 minutes in both directions. The newly designed Pullman cars, the features of which were announced by the road in the Spring of 1937, are now being turned out of the Pullman shops in Chicago. All sleeping cars of the new Broadway will be exclusively of the private room type.

The new equipment was designed jointly by engineers of the railroad and the Pullman Company, in collaboration with Raymond Loewy, industrial designer. The new cars will be placed not only on the Broadway but will also be used to re-equip partially the east and west bound General

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A scene from "Men Make Steel"—A wheel formed in a 10,000-ton hydraulic press



THREE CONDITIONS

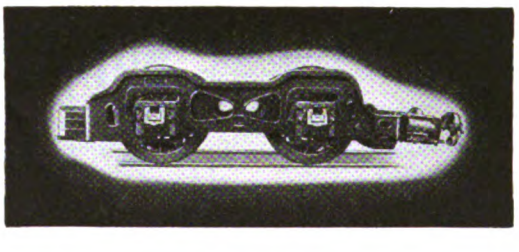
that modern locomotives must meet

1 A lower driving wheel load limit to suit high speed operation in relation to track.

2 High power output to pull the train at present-day speeds.

3 Limitation of starting power by the factor of adhesion.

These considerations have brought a new approach to the design of high-speed passenger locomotives. » » » The cylinders, pressure and driving wheels have been proportioned for the work to be done at the road speeds, using as few drivers as practical. » » » Leading and trailing trucks carry the remainder of the locomotive structure. » » » To restore the design to a proper balance, the deficiency in starting power is supplied by using The Locomotive Booster to put idle trailer weight to work. » » » This insures minimum number of driving axles and minimum weight on drivers, resulting in a locomotive that is easier on track. » » »



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NEW YORK CHICAGO MONTREAL

between New York and Chicago; the Liberty Limited between Washington, D. C., and Chicago; and the Spirit of St. Louis, between New York and St. Louis, Mo.

Upward Trend of Fuel Costs Shown in Study

THE continued decrease in unit fuel consumption and increase in unit fuel costs is clearly indicated in the accompanying table which has been developed by the Railway Fuel & Traveling Engineers' Association, from data issued currently by the Interstate Commerce Commission, Bureau of Statistics. Fuel figures for January and February, 1938, and a comparison with February, 1937, are given in the table.

Fuel Performances and Costs in Freight and Passenger Road Service, Class I Railways

	January, 1938	February, 1938	February, 1937	Per cent increase or decrease, 1938, compared with 1937
Coal per 1,000 gross ton-miles, lb. (including locomotive and tender)	127.0	125.0	130.0	−3.84
Fuel cost per 1,000 gross ton-miles, cents (including locomotive and tender)	18.05	17.77	16.89	+5.21
Coal per passenger-train car-mile, lb.	16.1	15.9	16.4	−3.05
Fuel cost per passenger-train car-mile, cents	2.28	2.26	2.15	+5.12
Average cost of fuel per equated net ton (coal equivalent)	$2.84	$2.85	$2.62	+8.78

With gross ton mileage for February, 1938, reduced 22.2 per cent below February, 1937, values, passenger-train car mileage reduced about 2.5 per cent and better unit fuel performance this year in both classes of service, the total cost of fuel and power consumed by the Class I railways at $19,840,000 was only 13.6 per cent lower than in February, 1937, because of the increase of 8.78 per cent in the price per equated net ton (coal equivalent). Curtailment of the volume of business has occurred principally in the commodities that permit slower movement in heavier trains, and has been accompanied generally by the reduced average engine loads resulting from the movement of a greater proportion of light commodities at higher speed.

The improvement in the unit consumption of fuel, notwithstanding the handicap of the drastic reduction in the volume of traffic and the change in its character, must be considered a creditable development.

Arch-Bar Cars Will Earn Rentals Until July 1 Deadline

THE Association of American Railroads on March 31 issued a ruling whereby freight cars equipped with arch-bar trucks will continue to earn regular per diem and mileage payments until July 1, the effective date of the order prohibiting the use of such cars in interchange service. When the A. A. R. last November extended the deadline from January 1 to July 1 it also provided that "after April 1, 1938, mileage or per diem shall not be paid car owners for cars equipped with arch-bar trucks."

The March 31 ruling lifts the latter proviso; the July 1 deadline remains unchanged. Meanwhile the supplement to the mileage tariff which proposed to cut off payments on April 1 has been withdrawn.

Data on the arch-bar truck situation given in the latest annual report of Director W. J. Patterson of the Interstate Commerce Commission's Bureau of Safety, estimated that, had the order become effective on January 1, the number of cars temporarily prohibited in interchange in the U. S. would have been "less than 150,000."

No Mechanical or P. & S. Meetings This Year

DECISIONS have been reached by the general committees of the Mechanical Division and the Purchases and Stores Division, A. A. R., to hold no annual meetings this year. Business conditions and necessity for the railroads and the A. A. R. to curtail expenses to the greatest possible extent are given as the reasons for the action. Committee reports containing definite recommendations will be considered by the general committee of each division and reports requiring further action will be subject to letter ballot vote and formal approval by each division at its next annual meeting.

New Equipment Orders and Inquiries Announced Since the Closing of the April Issue

LOCOMOTIVE ORDERS

Company	No. of locos.	Type of loco.	Builder
Canadian Pacific	10*	2-10-4	Montreal Loco. Wks.
Chilean State Railways	7	4-8-2	Baldwin Loco. Wks.
Southwest Missouri	2	30-ton gasoline †	Plymouth Loco. Wks.
Warrior River Terminal	1	900-hp.	American Loco. Wks.

FREIGHT-CAR ORDERS

Road	No. of cars	Type of car	Builder
Mathieson Alkali Works, Inc.	3	50-ton transport	American Car and Foundry Co.

FREIGHT-CAR INQUIRIES

General Chemical Co.	7–10	70-ton covered hopper	
Mathieson Alkali Works, Inc.	3–5	40-ton tank	
Pittsburgh Plate Glass Company	1	10,000-gal. tank	
Southern Railway	3,000	40-ton box	
	250	40-ton stock	
	200	50-ton furniture	
	1,000	50-ton D. B. gondola	
	500	50-ton gondola	
	25	70-ton gondola	
	25	70-ton flat	

PASSENGER-CAR ORDERS

Road	No. of cars	Type of car	Builder
Pullman	1	Sleeper ‡	Pullman-Std. Car Mfg. Co.

PASSENGER-CAR INQUIRIES

Southern	§		

* T-1-b class. These locomotives are for service on passenger trains between Calgary, Alta., and Revelstoke, B. C. They will be semi-streamline and will use oil as fuel. They are in addition to the orders for 25 locomotives reported in the April issue.

† Mechanical drive. One of these locomotives is to be placed in service between Webb City, Mo., and the Prosperity and Duenweg areas and one between Baxter Springs and Picher.

‡ Roomette Car No. 2; to contain 18 rooms.

§ Purchase of four Die el-electric passenger units contemplated. Type of car not yet definitely determined.

Supply Trade Notes

F. B. ERNST, vice-president of the American Steel Foundries, Chicago, has been elected a director.

◆

HERBERT H. MOFFITT, Hill building, Washington, D. C., has been appointed southern district manager for The Rails Company, New Haven, Conn.

◆

IRON & STEEL PRODUCTS, INC., Chicago, has discontinued its New York sales office, and will handle business in that territory from Chicago.

THE J. G. BRILL COMPANY has moved its St. Louis, Mo., office from 1558 South Vandeventer avenue to 705 Olive street. This office is in charge of R. S. Hood, Jr., district sales manager.

◆

THE COLUMBIA MACHINE TOOL COMPANY, Hamilton, Ohio, has purchased all the Long & Allstatter records, drawings, blue prints and patterns, and is prepared to furnish new improved design plate and structural steel machinery such as punches, shears, etc.

J. S. GAMMEL, eastern railway sales representative of the National Carbon Company, Inc., has been transferred to the general sales department of the Evertional Carbon Company, Inc., with headquarters at New York.

◆

A. J. ERLACHER has been appointed district manager of the J. G. Brill Company, in charge of a newly created sales territory comprising Maryland, Pennsylvania and southern New Jersey. Mr. Erlacher's

(*Turn to next left-hand page*)

WOULD YOU SPEND...

1 dollar



TO SAVE...

10 dollars



You accept locomotive arches as a matter of course; as a fundamental in locomotive design. But the Arch can only give you the full economy when each course and each arch brick is in place. Paring down the arch in an effort to save $1.00 costs you $10.00 for the extra fuel wasted by the shortened arch.

These proportions have been established by repeated tests on various types of motive power. So against any "saving" in arch brick expense by cutting down the arch, mark up $10.00 on the loss side of the ledger.

There's More To SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

headquarters are at Philadelphia. W. M. Horsell, district manager at Philadelphia, retains the sales territory comprising Metropolitan Philadelphia, Chester, Pa., Washington, D. C., Baltimore, Md., and the states of Delaware and Virginia.

◆

ALLEN W. MORTON has been elected a vice-president of the Koppers Company. Mr. Morton will continue in charge of Koppers' American Hammered Piston Ring Division, at Baltimore, Md., where he has been general manager.

◆

MOXIE S. GEORGE, assistant district sales manager of the Inland Steel Company, with headquarters at Milwaukee, Wis., has been appointed assistant manager of sales of the flat rolled steel division, with headquarters at Chicago.

◆

D. J. CROWLEY, formerly special representative of Hubbard & Company, Pittsburgh, Pa., with headquarters at Chicago, has organized the Universal Spring Washer & Supply Company, 6 North Michigan avenue, Chicago, to manufacture and sell the Universal spring washer, heretofore sold by Hubbard & Company.

◆

THE ALLOYS DEVELOPMENT CORPORATION of New York, with offices in the International Building, Rockefeller Center, New York, has been formed as a successor to the U. S. Rustless Steel & Iron Corporation. Frederick D. Foote and Dr. Beram D. Saklatwalla are associated in this enterprise. Mr. Foote, as president of the new corporation, will devote his entire time to the development and promotion of the low-cost, weight-saving steels whose use he initiated while railroad industry executive in the commercial office of the United States Steel Corporation. The association of these two men brings together the metallurgist whose work with chromium-copper steels pointed the way to Cor-Ten, a product developed by United States Steel Corporation research, and the commercial executive of that corporation who early recognized the important role which this steel and others of its kind seemed destined to play in industry.

The Alloys Development Corporation holds patents in many steel-producing countries, controlling a number of low chromium-copper alloys. It will be the aim of the newly organized corporation to develop and promote new materials for industrial and structural uses throughout the world. Other members of the board of directors include Edwin Hodge, Jr., president of the Pittsburgh Forgings Company, and Carl W. Ehni, vice-president of the Peoples-Pittsburgh Trust Company, both of Pittsburgh, Pa.

Frederick D. Foote was born in Flint, Mich., and began his business career in the inspection department of the Buick Motor Company. A year later, in 1908, he was appointed chief inspector of one of the plants of the Weston Mott Company, maker of front and rear automobile axles, since acquired by the General Motors Corporation. In 1911 he went to Detroit to engage in home designing and construction, but shortly thereafter became associated with the Greenville Steel Car Company of Greenville, Pa., at that time a maker of front and rear automobile axles. He served successively with this



F. D. Foote

company as purchasing agent, secretary and treasurer, and president. His contact with the railway equipment industry started when the Greenville Steel Car Company became interested in the repair and building of steel freight cars. This company became a subsidiary of the Pittsburgh Forgings Company in 1930, and Mr. Foote was elected president of the latter company in April, 1932. In 1933 he went with the United States Steel Corporation.

Dr. B. D. Saklatwalla was born in Bombay, India, in July, 1881. He studied at the University of Bombay, obtaining the degree of bachelor of science in chemistry in 1901. Later he attended the University of Berlin, in Germany, and the Royal Polytechnicum at Charlottenburg, from the latter of which he obtained the degree of chemical and metallurgical engineer in 1906. He was awarded the degree of doctor of engineering in 1908. In 1907 he was elected a Carnegie research scholar



Dr. Beram D. Saklatwalla

by the Iron and Steel Institute of Great Britain and awarded a grant for conducting research on the effect of phosphorus in steel. In 1908 Doctor Saklatwalla left Germany for the United States and in 1909 became associated with the American Vanadium Company, developing the alumino-thermic reduction process and later the electro-thermic reduction process for the smelting of vanadium ores. He became general superintendent of the American Vanadium Company and occupied the same position with its successor, the Vanadium Corporation of America, advancing to the position of senior vice-president and director of this corporation, which he filled until October, 1935, when he formed the U. S. Rustless Steel & Iron Corporation. In 1924 Dr. Saklatwalla was awarded the Grasselli Medal by the Society of Chemical Industry for his research work in chromium-copper corrosion-resisting steels.

◆

CHARLES L. BROWN, western sales manager of the Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., New York, has retired at his own request, after 32 years of service. Mr. Brown began work with Manning, Maxwell & Moore in Chicago, on July 1, 1906, as the company's only representative for the west and mid-west. Under his guidance, a sales organization was developed for this section and he became western sales manager. Robert Watson succeeds Mr. Brown as western sales manager of the Locomotive Equipment Division, with office in the Field building, Chicago. Mr. Watson was formerly with the Waugh Equipment Company, the Erie Railroad and the American Locomotive Company.

◆

THE AMERICAN CAR AND FOUNDRY COMPANY has moved its St. Louis, Mo., office from 1558 South Vandeventer avenue to 705 Olive street.

◆

THE TRANE COMPANY, La Crosse, Wis., manufacturers of heating, cooling and air-conditioning equipment, have leased space at Bush terminal in New York City for warehousing and assembly facilities, which will be under the management of the Trane New York office, 250 East 43rd street.

◆

JOHN S. LEMLEY, vice-president and a director of the T-Z Railway Equipment Company, Chicago, and the Morris B. Brewster Company, Chicago, with headquarters at St. Louis, Mo., has resigned following the sale of his interest in both companies and will engage in the sale of railway supplies at St. Louis. He entered the railway supply business in 1915 in association with George F. Cotter of Houston, Tex. In 1920 he became associated with the Charles R. Long Paint Company, Louisville, Ky., and the Viloco Railway Equipment Company and the Okadee Company, of Chicago. Following the sale of his interest in these companies he purchased an interest in the T-Z Railway Equipment Company and the Morris B. Brewster Company on January 1, 1930. Mr. Lemley is a co-inventor of several products used by railroads.

◆

THE UNITED STATES STEEL CORPORATION, at a meeting of its board on April 5, elected Edward R. Stettinius, Jr., as chairman of the board, succeeding Myron C. Taylor, and Mr. Stettinius retired from the chairmanship of the finance committee. Edward M. Voorhees retired as vice-chair-

(*Turn to next left-hand page*)



NINE new streamlined locomotives of the 4-6-4 type have been completed for the Chicago and North Western to speed up the heavy passenger trains between Chicago and Omaha. The trains in this service, usually consisting of 14 to 16 cars, have outgrown the capacities of the existing 4-6-2 engines which previously hauled them.

The new streamlined locomotives, attractively sheathed and painted to harmonize with the new cars also operating in this service, develop maximum possible power obtainable with three driving axles.

NEW POWER — NEW PROFITS

Weight on Drivers	216,000 pounds	Diameter of Drivers	84 inches
Weight of Engine	412,000 pounds	Boiler Pressure	300 pounds
Cylinders	25 x 29 inches	Tractive Power	55,000 pounds

AMERICAN LOCOMOTIVE COMPANY

30 CHURCH STREET · NEW YORK · N.Y.

man of the finance committee and was elected chairman of that committee. Benjamin F. Fairless was re-elected president of the United States Steel Corporation of New Jersey and becomes the chief administrative officer. Mr. Fairless is also president of the United States Steel Corporation of Delaware, the management corporation, with which the principal manufacturing subsidiaries have management contracts, with headquarters at Pittsburgh, Pa. Philip R. Clarke, president of the City National Bank & Trust Company of Chicago, was elected a member of the board of directors to succeed E. J. Buffington, deceased.

◆

THE JONES & LAUGHLIN STEEL CORPORATION, Pittsburgh, Pa., has appointed three new assistant general managers of sales; opened a new district sales office at Baltimore, Md., and made promotions and new appointments in several of its district sales offices. R. T. Rowles has been appointed assistant general manager of sales and will supervise the general activities of the hot-rolled, cold-finished, wire-products, and warehouse-sales departments. He entered the service of Jones & Laughlin in 1912 and in 1925, was appointed manager of hot-rolled sales. W. H. Wiewel has been appointed assistant general manager of sales and will supervise the general activities of by-products and pig-iron, sheets-and-strip, tinplate, and tubular-products sales departments. He joined Jones & Laughlin in 1935 as manager of sales of tubular products and had previously entered the steel business in 1910, with the Cambria Steel Company. H. J. Watt has been appointed assistant general manager of sales and will have charge of New York City and the East, with general supervision over district sales offices in Boston, Mass., New York, Philadelphia, Pa., Atlanta, Ga., and the new district sales office in Baltimore. Since 1935, Mr. Watt has served as district sales manager at New York. He entered the steel business in 1912, in the Philadelphia office of the Carnegie Steel Company and since 1925 has been in the service of Jones & Laughlin. Arthur A. Wagner, assistant manager of hot-rolled sales, has been appointed manager of hot-rolled sales, succeeding Mr. Rowles; John O'H. Anderson, assistant district sales manager at New York, has been appointed manager of sales, tubular products, succeeding Mr. Wiewel, and E. J. Dickson has been appointed assistant manager of sales, tubular products, at Pittsburgh. The following have been appointed district sales managers: V. A. Jevon, at Baltimore, Md.; John B. DeWolf, Philadelphia, Pa.; Edward H. Hughes, St. Louis, Mo.; Thomas C. Ham, having been transferred from Philadelphia to Pittsburgh, to supervise the corporation's industrial training plan, J. B. Hungate having resigned. Assistant district sales managers have been appointed as follows: H. R. Dorney, at Baltimore; Herbert B. Spackman, Philadelphia; William K. Breeze, New York; Hughart R. Laughlin, New York; F. B. Kittredge, Boston, Mass., and Charles M. Mason, Buffalo, N. Y.

Obituary

HAROLD A. KNAPP, vice-president and general sales manager of the Celotex Corporation, Chicago, died on March 24 at Waukegan, Ill., of a heart ailment.

◆

JOHN E. BRADLEY, former president of the Osgood Bradley Car Company, Worcester, Mass., died on April 4, at the age of 78, while vacationing in Bermuda. The business was founded by his grandfather as a stage coach manufacturer in 1848, and later developed into the production of railroad cars and trolley equipment. The company was sold in 1930, and is now part of the Pullman-Standard Car Manufacturing Company.

Personal Mention

General

C. P. VAN GUNDY, engineer of tests of the Baltimore & Ohio at Baltimore, Md., is retiring after 46 years of service.

J. H. MCGOFF, mechanical superintendent of the mechanical district, Eastern lines, of the Atchison, Topeka & Santa Fe at Shopton, Iowa, is retiring, at his own request, after 35 years' service.

EUGENE B. MILLER, special inspector on the staff of George H. Emerson, chief of motive power and equipment of the Baltimore & Ohio, has retired. Mr. Miller had been in the service of the B. & O. for over 51 years.

J. P. MORRIS, mechanical assistant in the general office of the Atchison, Topeka & Santa Fe at Chicago, has been appointed mechanical superintendent of the Eastern mechanical district of the Eastern lines, with headquarters at Shopton, Iowa, to succeed J. H. McGoff.

OLIVER C. CROMWELL, assistant to chief of motive power and equipment of the Baltimore & Ohio, with headquarters at Baltimore, has retired after 58 years of active service. Mr. Cromwell was born in Baltimore on August 29, 1860, and entered the service of the Baltimore & Ohio as an apprentice draftsman on July 1, 1878. He was mechanical engineer from 1900 to 1918, when he became assistant to general superintendent of motive power and equipment. In February, 1921, he was appointed assistant to chief of motive power.

THEODORE OLSON, master mechanic, Chicago Great Western, Oelwein, Iowa, has been appointed superintendent motive power, succeeding H. W. Reinhardt, who has resigned.

A. B. COLVILLE, superintendent of shops at Hillyard, Wash., for the Great Northern, has been appointed superintendent of motive power at Spokane, Wash., succeeding A. B. Ford.

W. R. HEDEMAN, assistant to chief of motive power and equipment of the Baltimore & Ohio, at Baltimore, Md., has been appointed engineer of tests, with the same headquarters, succeeding C. P. Van Gundy.

EDMUND E. CHAPMAN, engineer of tests of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan., has been appointed mechanical assistant to the assistant to the vice-president, with headquarters at Chicago, succeeding J. P. Morris. Mr. Chapman will continue to serve as engineer of tests. He was born on January 3, 1884, at Mankato, Kan., and was educated in the Concordia (Kan.) high school and at Purdue University, graduating from the course in mechanical engineering in 1907. After serving briefly with the Erie as a special apprentice, Mr. Chapman entered the service of the Santa Fe in December, 1909, as an assistant in the test department at Topeka. Following military service as captain and major in the ordnance department, he returned to the Santa Fe in June, 1919, as assistant engineer of tests, and became engineer of tests on March 1, 1921.

Master Mechanics and Road Foremen

L. W. GOODRICH, acting master mechanic of the Atchison, Topeka & Santa Fe at Chicago, has been appointed master mechanic.

J. P. BECKER, general locomotive and boiler inspector of the Chicago Great Western at Oelwein, Iowa, has been appointed master mechanic at Oelwein to succeed Theodore Olson.

W. V. HINERMAN, assistant master mechanic of the Cincinnati Division of the Chesapeake & Ohio, has been appointed master mechanic of the Hinton Division, with headquarters at Hinton, W. Va. The jurisdiction of the Hinton division had temporarily been in the hands of J. D. Davenport who is now master mechanic of the Clifton Forge Division.

Car Department

THOMAS H. RUSSUM, supervisor of passenger-car maintenance of the Baltimore & Ohio at the Mt. Clare (Baltimore), Md., shops, has retired after 54 years of continuous active service.

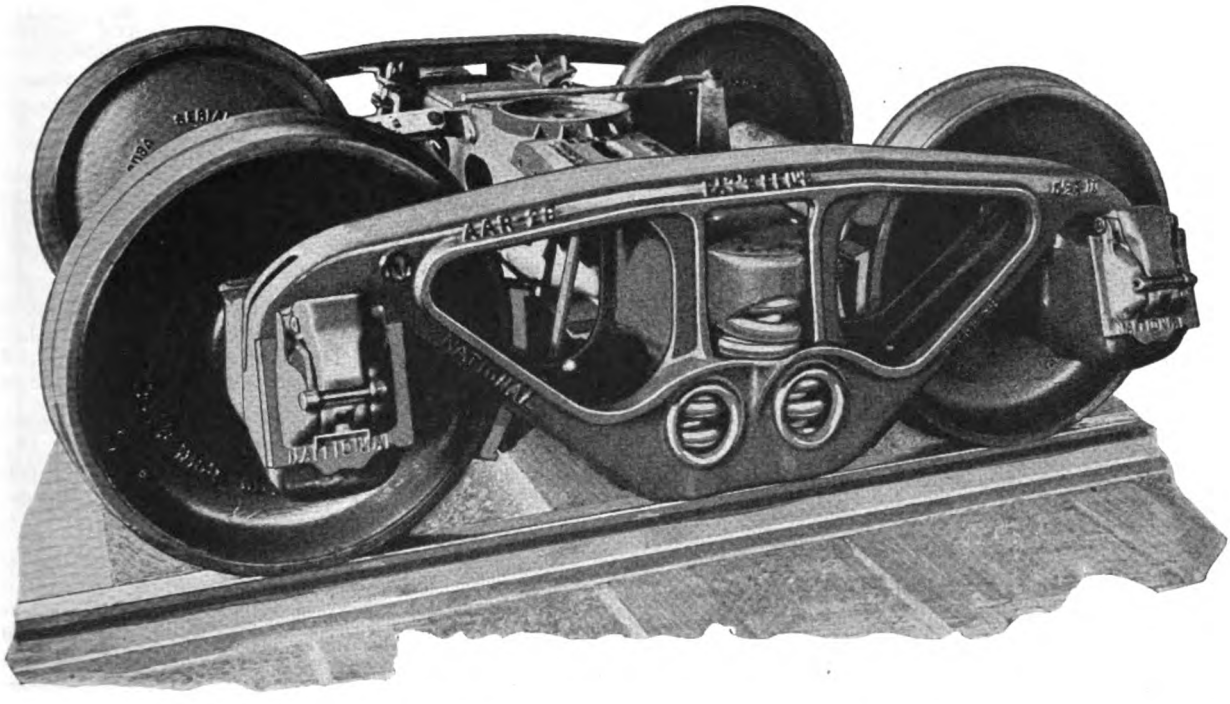
P. H. MITCHELL, general car inspector of the Delaware, Lackawanna & Western, with headquarters at Scranton, Pa., has been appointed master car builder, with the same headquarters.

(*Turn to next left-hand page*)

Note This

NATIONAL TYPE B

SPRING—PLANKLESS TRUCK



The Pioneer in Modern Truck Design Now in the Seventh Year of Production.

MAXIMUM availability and minimum operating expense of your freight cars are notable achievements obtained by National Type B Spring-Plankless Trucks.

Cars are rewheeled in shortest possible time, a matter of minutes instead of hours due to the simple construction—Spring breakage is minimized and spring loss entirely prevented with the enclosed design found only in National Type B Trucks.

All mechanical features are in advance of designs that have make-shift arrangements to eliminate the spring plank. These features have been embodied in the National Truck for over six years, making it the most reliable money-saving truck for your freight cars.

NATIONAL MALLEABLE AND STEEL CASTINGS CO.

General Offices: CLEVELAND, OHIO

Sales Offices: New York, Philadelphia, Chicago, St. Louis, San Francisco.

Works: Cleveland, Chicago, Indianapolis, Sharon, Pa., Melrose Park, Ill.

Canadian Representatives: Railway and Power Engineering Corporation, Ltd., Toronto and Montreal

WILLIAM H. PIRIE, general car foreman of the Canadian National at Halifax, N. S., has retired.

EDWARD M. JENKINS, who has been appointed master car builder of the Delaware, Lackawanna & Western at Scranton, Pa., as noted in the April issue, was born on June 28, 1886, at Vermont, Ill., and was educated in the public schools and the University of Illinois. From July, 1909, to September, 1911, Mr. Jenkins served as special apprentice for the Baldwin Locomotive Works and from the latter date until July, 1926, successively, as draftsman on the Baltimore & Ohio, chief draftsman for the Seaboard Air Line, mechanical engineer for the Virginian and special mechanical inspector for the Chesapeake & Ohio. In July, 1926, Mr. Jenkins was appointed chief draftsman, car department, Delaware, Lackawanna & Western and in May, 1927, became master car builder at Scranton.

Shop and Enginehouse

W. H. SHOW, foreman of the Norfolk & Western at Eckman, W. Va., has retired.

A. A. BURKHARD, superintendent of shops of the Merchants Despatch Transportation Corporation at East Rochester, N. Y., has retired.

EARL C. KELLOCK has been appointed enginehouse foreman of the Canadian National, with headquarters at Stellarton, N. S., succeeding James Blair, retired.

ROBERT R. ROYAL, who has been appointed shop superintendent of the Illinois Central with headquarters at Paducah, Ky., was born at Water Valley, Miss., on August 10, 1881. He attended high school and night school and entered railway service as a machinist apprentice on the Illinois Central on October 1, 1898. Upon the completion of his apprenticeship in 1902, he served as a machinist, first at Water Valley and then at McComb, Miss. From June, 1903, until September, 1904, Mr. Royal was employed, successively, by the Colorado Southern at Trinidad, Colo., the Southern Pacific at Sacramento, Calif., the Nashville, Chattanooga & St. Louis, at Nashville, Tenn., and the Southern at Atlanta, Ga. He then returned to the Illinois Central as a machinist and in September, 1907 became a machinist and foreman on the Missouri Pacific. He subsequently became a foreman on the Mobile, Jackson & Kansas City at Louisville, Miss., reentered the service of the Illinois Central as a machinist at Water Valley in July, 1908, and in April of the following year was promoted to gang foreman. In July, 1910, he was transferred to Durant, Miss., as district foreman, and in March, 1911, became enginehouse foreman at Water Valley. He subsequently became a machinist in the employ of the Southern at Princeton, Ind.; the St. Louis-San Francisco, and the Atlantic Coast Line at Waycross, Ga. He then served as a foreman of the St. L.-S. F. at Memphis, Tenn., becoming enginehouse foreman of the Illinois Central at Water Valley in January, 1913. In January, 1916, he was promoted to the position of general foreman at Water Valley; in October, 1917, was transferred to McComb, Miss., as general foreman, and on August 15, 1927, was transferred to Paducah, Ky., as general foreman. In December, 1929, he became master mechanic at Paducah and in January, 1938, was appointed shop superintendent at Paducah.



Robert R. Royal

Obituary

FRANK J. O'CONNOR, assistant purchasing agent of the Chicago, Milwaukee, St. Paul & Pacific at Chicago, died at Phoenix, Ariz., on March 24.

J. E. WHITE, who retired on June 1, 1931, as master mechanic of the Louisville & Nashville at Pensacola, Fla., died in that city on March 22 at the age of 75.

ERNEST F. STROEH, formerly mechanical superintendent of the Missouri Pacific at St. Louis, Mo., who retired in April, 1932, as master mechanic, died in Denver, Colo., on March 17. He was 63 years of age.

H. S. BURR, formerly general superintendent of stores of the Erie, who retired from active service in 1931, died at Hornell, N. Y., on March 23. Mr. Burr was a past president of the Railway Storekeepers Association.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

CERTIFIED STEELS.—Joseph T. Ryerson & Son, Inc., Chicago. 28 pages, illustrated. Describes Ryerson system of furnishing quality-controlled steels from stock; specifications and suggestions for heat treaters.

◆

SPRAY-FINISHING EQUIPMENT. — The DeVilbiss Company, Toledo, Ohio. Catalog "ID". 28 pages, illustrated. Covers complete DeVilbiss line of industrial spray-painting and finishing equipment and gives full specifications on all standard items.

◆

FUNDAMENTALS OF GOOD REFRIGERATOR INSULATION.—Dry-Zero Corporation, Merchandise Mart, Chicago. 44 pages. Explains theory of insulation and its application to all types of refrigerated and air-conditioned containers, including railroad passenger and refrigerator cars. Sections deal with insulating materials; influence of moisture, and test results obtained by Dr. J. L. Finch at U. S. Bureau of Standards.

WELDING INSTRUCTIONS AND STANDARDS. —United States Steel Corporation Subsidiaries, Box 176, 434 Fifth avenue, Pittsburgh, Pa. Part I, Symbols and Method of Showing Welding on Drawings. 81 pages, spiral bound. Price, 50 cents. First of a series dealing with all phases of welding; others soon to be issued.

◆

ENGINEERING DATA FILE. — Packless Metal Products Corporation, Long Island City, N. Y. Bulletin 100. Descriptive matter and specification data sheets on Packless seamless flexible metal hose, detachable self-sealing couplings, self-flaring tube couplings and copper tubing.

AMMONODUCT.—Bethlehem Steel Company, Bethlehem, Pa. Four-page illustrated folder describing a special fatigue-resisting pipe for freight- and passenger-car air lines, and for locomotive water, air and steam lines.

◆

"THE STORY OF THE BRAKE SHOE."—The American Brake Shoe and Foundry Company, 230 Park avenue, New York. 52 pages, illustrated. A historical record of braking in general and the development of a satisfactory composition and shape for standard railroad brake shoes in particular.

◆

TURRET LATHE TOOLS.—The Warner & Swasey Company, Cleveland, Ohio. Catalog and Manual No. 38, 176 pages, wire bound. Chucking tools, bar tools, cross-slide tools, holding devices, and semi-standard and special tools. Machine data sheets, speed and feed charts, diagonals of hexagons and squares, etc.

RAILWAY MECHANICAL ENGINEER

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.

"There is no stalemate of diminishing interest in railway problems but rather a stepping up, an increasing efficiency, a newness amounting to actual genius. Abiding in the men who have had their share in this general uplift there must be a feeling of elation, of adventure, and of that deep satisfaction which compensates far beyond monetary award. And it is certain that that character of man, having achieved this day's success, will not be content to rest on present laurels, but rather will go on to still higher achievement."

Ralph Budd,
President, Burlington Lines

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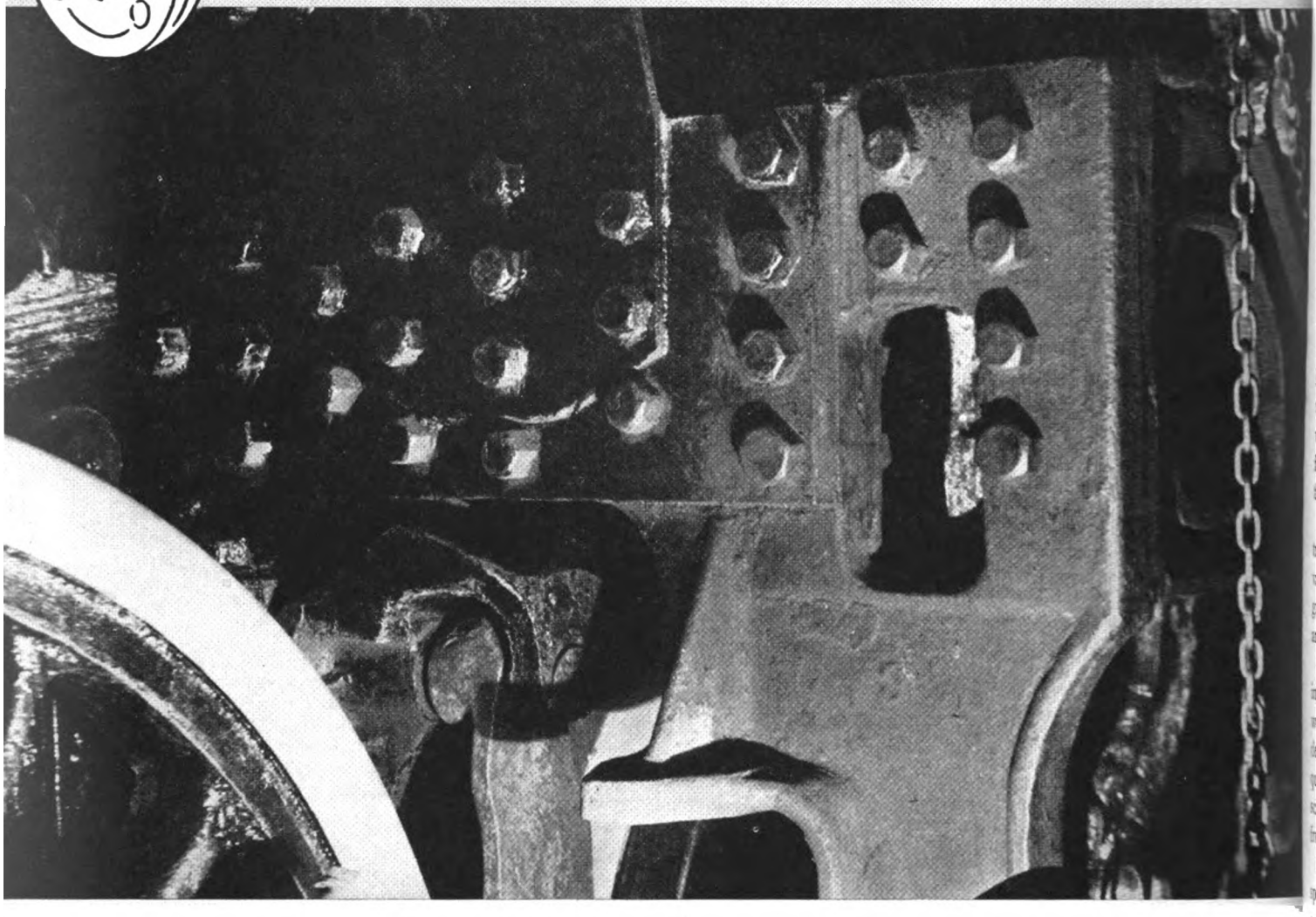
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Locking the Stable Door *after . . . ?*



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RAILWAY
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A Record of Remarkable Accomplishment

This issue presents a review of recent striking accomplishments and the present trends in railway transportation. It evaluates the part which mechanical departments and the designers and developers of motive power, rolling stock and auxiliary equipment have taken in bringing them about. There is presented a remarkable picture of new materials, of interdependent and simultaneous refinements in design of motive power and rolling stock, and of new types of facilities. Not the least remarkable part of the picture is the evidence of vision in the railway industry presented by the way in which all of these newly available improvements and facilities have been adapted to the new competitive situation of the railways and to their need for economy.

The outstanding characteristics of modern railway transportation service, to which these mechanical advancements have contributed, are increasing speed, greater reliability and economy of train performance and increasing sensitiveness to the public taste.

The railroads owe the present movement for increasing passenger-train speeds to new Diesel-driven lightweight streamline passenger trains. These trains have demonstrated two things: The importance of an adequate power-weight ratio for maintenance of fast schedules, and the high availability and relative freedom from service delays of the Diesel locomotive.

But the steam locomotive is also capable of high speeds. Better counterbalancing and the increasing concentration of horsepower capacity in the modern steam locomotive have retained for it its long established position of an all-round motive-power unit, whether for the fastest passenger service or the heaviest freight service.

Running speeds of freight trains have also been increased. This is evidence of the increasing mechanical reliability of freight-train cars. Contributing to increasing speeds in both services are the new air brake equipments.

Improvements in reliability of both motive power and rolling stock have contributed materially to the increase in economy of train performance. Increasing capacity and efficiency of the steam locomotive have also been large factors in this direction. Indeed, the greatest value of higher efficiency lies in the increased capacity which it makes available for moving heavier trains faster. Better freight-car designs are keeping cars off the repair tracks and reducing dangerous failures in service. Freight cars of lighter weight and higher ratios of lading capacity to gross load promise definite and worthwhile savings in operating expense.

All of these developments have depended upon improved materials which have become available at various times during the past ten years. Among these materials are the alloy boiler steels, the aluminum alloys and stainless steels which have been employed in passenger-car construction, and the low-alloy, high-tensile structural steels which are being used extensively in the building of both passenger and freight cars. Special alloy steels for locomotive forgings are giving new impetus to the lightening of reciprocating parts of the steam locomotive, and alloy-steel truck castings are contributed to the reduction of the passenger-car and freight-car weights.

In passenger service, the growing sensitiveness to the public taste is evidenced in many ways. In addition to its own contribution to comfort, air conditioning has permitted a range of choice in color and decorative treatment which has opened an entire new field to the interior decorator. Streamlining, which possesses some economic advantages at high speeds, has really become a term which signifies exterior styling of passenger cars and locomotives. It has endowed high speed with glamour and has done much to restore the long dormant popular interest in the railway.

The accomplishments in a field of motive power and rolling stock include improvements in maintenance as well as in operation. The modern steam locomotive has many features built into it which are coming to spell reduced maintenance. Improvements in the shops are also being made which will increase still further the economies in maintenance expenses which have been effected in recent years by more systematic attention at terminals and better organized and more specialized operations in the shops.

The accomplishment as a whole is one which all those, either on the railroad or in the supply and equipment industries, who contributed to it may regard with real satisfaction. It is of a nature which promises continued progress in the future.



The Mechanical Department's

Contribution to Railway Progress

By Ralph Budd
President, Burlington Lines

WHAT has been the contribution of the mechanical department to railroad progress? As we glance back a bit at the actual accomplishments of only the past few years and consider what is now in the making we realize that somewhere there must be a body of men whose activities in designing, building, running and maintaining our new style light-weight high-speed passenger trains are distinctly contributing to railway progress. That same body is also active in the improvements that have lately come to steam locomotives and their handling and repairing, and have had to do with Diesel locomotives, for it should be borne in mind that a Diesel engine, as such, is not a locomotive any more than it is a boat. That body is also the presiding genius of the activities surrounding our improved freight cars, improved shop tools and improved methods and devices almost endless and without number.

Men with Ideas

The men comprising this body have ideas. Perhaps a better way to express it is that men who have ideas are those who compose this body, regardless of how far down the line they may seem to themselves to be. Why should anyone be surprised that a railway mechanical man, with his reasoning processes on specific matters brought to a keen edge through his daily struggle with adverse factors and emergencies of varying character, should have ideas? It is under such circumstances that creation most often has its being: Such an atmosphere is a very mother of ideas. Many a creation first saw the light of day in the remote recesses of a roundhouse, or locomotive shop, or car shop, or drafting room; and the cumulative effect of a constant flow of ideas, of improvements large and small originating largely on the railroad itself, refreshing its being and assisting it in maintaining its position as a transportation machine against the keen competition it faces must of necessity contribute enormously to railway progress.

Noteworthy Accomplishments

And what this body of men has wrought! Streamlined light-weight trains and semi-light-weight trains of surpassing quality and merit, air conditioned, artistic and luxurious, fine riding at the highest speeds, are making good in the most exacting high-speed railroad service the world has ever known. Trains of glittering stainless steel, of aluminum alloy, and of the lesser alloys; made possible first by the metallurgist in producing materials better suited to the purpose, secondly by the devisors of methods for working and fabricating these alloys to the best advantage, and lastly by experienced designing engineers who proportion the structure and shape the material to the load, taking due heed of its virtues, not forgetting its failings, and remembering that every surplus pound of weight saved gives continual saving in operating expenses throughout the life of the train. While there may be divisions of opinion as to what material and what construction is the most worthy as a durable mechanical structure and the most appealing as to artistic satisfaction or glamour, let it be borne in mind that all these trains are receiving high public approval and are building up a renewed public interest in and consideration for the railroads, as such.

Brakes Make High Speeds Possible

What travels fast must be stopped fast if safety is to be furthered and it is comforting to know that the advance in brake efficiency has kept pace with the advance in travel speed. Electric in operation and instantaneous in response these brakes are designed to give maximum shoe pressure at high speed, tapering off to reduced shoe pressures at lower speeds, all in reverse step with the increasing coefficient of friction between the shoe and the wheel as the train slows up. Then, too, we have close in the offing some promising, even radical, improvements which, if their day-by-day performance continues as good as their test performances, should very greatly improve braking performance. One of these is the use of disc, or drum, brakes which, in addition to taking the brake shoe pressure away from the tread of the wheel and increasing its life thereby, also provides a higher retardation possibility than at present. Another development is a wheel anti-skid device which automatically removes the brake pressure from a skidding wheel, holding it in abeyance until the wheel comes back to normal speed, at which time it is automatically reapplied.

The "Iron Horse"

Steam locomotives, both freight and passenger, now have greater speed, power, fuel economy, availability and general worth than the locomotives of a few years ago. In the design of these locomotives an ever increasing consideration for the track—that uncomplaining member of the railroad family—is coming to the fore and is in keeping with a more intelligent use of the existing railroad facilities. Counterbalancing methods have been improved and, what is even more to the point, a renewed interest in reduction of weight of reciprocating parts is manifesting itself. Weight distribution to the various locomotive wheels is now more often made with an eye to causing less shock and distortion to the track as the locomotive rolls along, an easing of the locomotive into the track so to speak. Driving wheels are made larger with resulting benefit to both track and locomotive; because in making less revolutions per mile the rails receive fewer and lessened dynamic impacts, the revolving and reciprocating parts are subjected to less wear and there is an improvement in steam distribution and cylinder horsepower due to the slower movement of the piston valve in relation to train speed.

Whether for better or for worse, it is becoming a conventional practice to streamline, or smoothline, locomotives assigned to high-speed passenger service. Roller bearings are aiding in cutting down the cost of maintenance and in keeping the locomotive out of the roundhouse. There are locomotives in this country today that are 100 per cent roller bearing; roller bearings being used on all axles, all crank pins, the crosshead and the valve gear bearings.

The use of steam for prime movers is being energized in no uncertain way and it is fair to assume that the coming of the Diesel locomotive, with its economy in operation and its high availability for service, has had something to do with this new pep. The railroads are fortunate indeed in being in a position to benefit from this new rivalry.

Light-Weight Freight Cars

Freight cars of alloy steel are now being built for the double purpose of reducing dead weight and reducing the ravages of rust. For a reasonable advance over the cost

of conventional carbon steel an alloy can be had which will not only substantially slow down the rusting process but which, because of its higher physical qualities, will carry greater load per pound of material. It is interesting to note too, how direct and simple are some of the designs of today when compared with equipment of an older school. Improvements have been made in the springing of freight cars to such an extent as to reduce complaints of shippers and claims for damage.

These considerations and other evidence indicate that there is no stalemate of diminishing interest in railway problems but rather a stepping up, an increasing efficiency, a newness amounting to actual genius. Abiding in the men who have had their share in this general uplift there must be a feeling of elation, of adventure, and of that deep satisfaction which compensates far beyond monetary award. And it is certain that that character of man, having achieved this day's success, will not be content to rest on present laurels, but rather will go on to still higher achievement.

High Speed and High Traction Characterize

Modern Motive Power

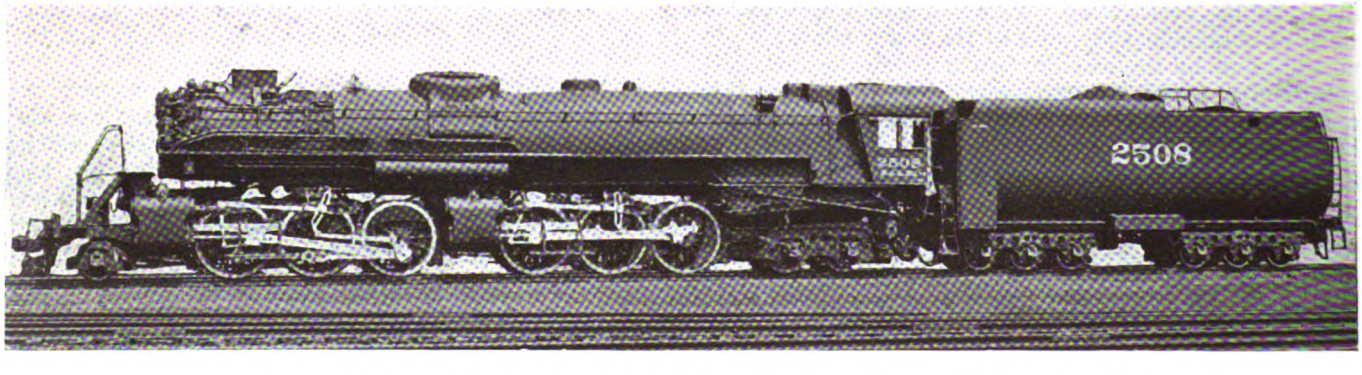
Diesel passenger locomotives grow to 5,400 engine horsepower — Horsepower capacity per driving axle of steam locomotives continues to increase as the result of better boiler proportions — Mechanical refinements and stamina keep pace with growing capacity

LOCOMOTIVE capacity has always been the key to economy in train operation. This was true in former days when direct tonnage rating and locomotive tractive force were the sole yardsticks. It is still true today when ton-miles per train hour and locomotive horsepower are the units of measurement.

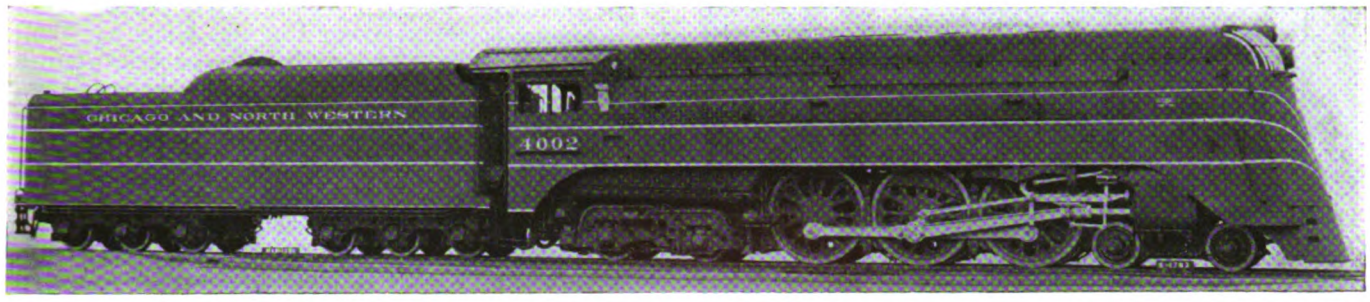
Train-operating expenses run so largely by the mile or the trip that the greatest field for economy in train operation has always been the reduction of train-miles. This means more tractive force. During the period of intensive development in locomotive economy, effected by the so-called economy- and capacity-increasing devices, overtime became an important factor in train-mile costs. Increased fuel and water economy were, therefore, converted into increased horsepower output and increased freight-train speeds. A new unit for measuring train performance became current—gross ton-miles per train hour.

Greater tractive capacity and heavier trains increased gross ton-miles per train hour, but did not reduce overtime. Resort could sometimes be had to reducing tonnage to increase gross ton-miles per train hour and to reduce overtime. But such an adjustment increased train-miles and so did not help much in reducing the direct costs of moving a given volume of freight traffic.

From being a by-product of improvements in economy increased horsepower capacity has become a major objective in its own right. During the 13 years since the introduction of the four-wheel trailer and the enlarged firebox there has been a steady advance in horsepower capacity as new freight locomotives have gone into service. Train speeds have been increased and so have the train loads. The modern locomotive in freight service moves more tons over the road in fewer hours, thus effecting marked increases in gross ton-miles per freight-



A modern freight locomotive is high both in traction and speed capacity



A fast, streamline passenger locomotive built for the Chicago & North Western by the American Locomotive Company

train hour and reducing crew overtime. In 1922 the crew overtime hours paid for in through-freight-train service on Class I railroads averaged more than 25 per cent of the straight time worked. In 1937 this had dropped to about 5 per cent of the straight time worked. During the same period average freight-train loads have increased from 1,466 to 1,902 tons (30 per cent) and average gross ton-miles per train hour from 18,200 to 30,349 (67 per cent). Thus, again, the increasing capacity of the steam locomotive—this time, the capacity for higher sustained speeds without sacrifice of train load—is the measure of its increasing potential operating economy in freight service.

In passenger-train service horsepower has always been the measure of locomotive capacity. The increasing weight of cars and number of cars in through trains has placed a steadily increasing demand for greater passenger-locomotive horsepower throughout much of the past 30 years. With that has now come the movement toward higher scheduled passenger-train speeds. The combined effect of these two demands is to require high tractive capacity with great horsepower capacity.

It will be observed that there has been a decided narrowing of the differences in characteristics of freight and passenger locomotives. Heavy passenger power now approaches the freight power in tractive capacity and freight power approaches passenger power in boiler and horsepower capacity.

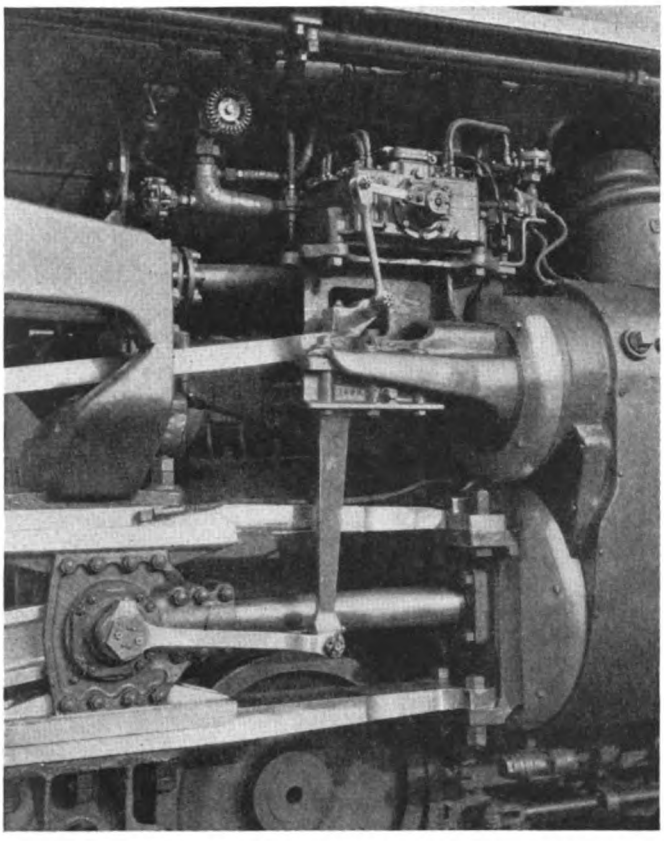
Diesel-Electric Locomotives

With the introduction of lightweight streamline passenger trains there began an extension of Diesel-electric motive power into passenger-train service. With the early short trains the power plant was installed in the front end of a revenue vehicle. The demand for increased revenue capacity, however, soon increased the load to the point where full Diesel-electric locomotive units were required. From the 600 hp. rail-motor car, the motive-power units have grown to 1,800 and 2,100 hp. in single-unit locomotives to 3,600 hp. in double-unit locomotives and 5,400 hp. in triple locomotive units.

The novelty of the Diesel motive power is the basis for a part of the glamour which has been created around some of the lightweight articulated high-speed trains. Entirely aside from this factor, however, these locomotives have other useful qualities, such as the ability to operate for long distances without the need of stops for servicing and the ability to have necessary maintenance work done piecemeal without removing the locomotive from service.



A 5,400-hp. Diesel-electric locomotive in three units built for the Union Pacific by the Electro-Motive Corporation



High-tensile alloy steels and refinements in design are the features of modern light reciprocating parts

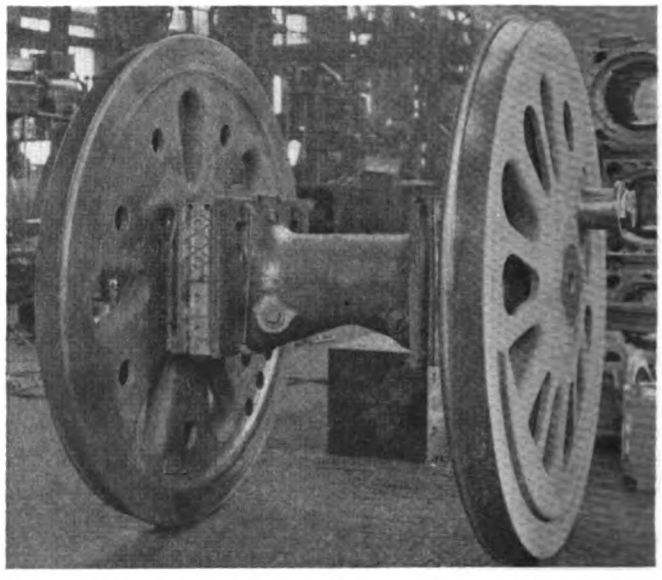
The position of the Diesel-electric locomotive in switching service is well established. Notwithstanding the present full-crew requirements, its high availability, high rate acceleration at low speeds and freedom from stand-by losses where the active work is intermittent adapt it to many yard and transfer jobs. So far as the cost of maintenance is concerned, adequate data, by which convincing comparisons can be made between Diesel locomotives and steam locomotives, either in switching or in road passenger service, have not as yet been made available.

Factors Contributing to Increased Steam-Locomotive Horsepower

Many factors have contributed to the growing horsepower capacity of the steam locomotive. Notable among these are higher steam pressures and temperatures, better boiler proportions, and improvements in the entire chain of factors in the combustion sequence from the grates to the stack. During the past 13 years boiler pressures have increased from about 200 lb. per sq. in. to 275 or 300 lb. per sq. in. with fireboxes of staybolt construction and, in a few cases of water-tube fireboxes, still higher pressures have been employed. An increase from 200 to 275 lb. pressure, which may be considered typical, along with an increase of 100 to 150 deg. in steam temperature, has produced an increase in effective output for approximately the same input of nearly one-third. The capacity added by the feedwater heater was available in the best locomotives of the earlier period, and the only influence on the trend since that time is that due to its more nearly universal application on the new locomotives of today. The Type E superheater has been the agency by which the effective increase in steam temperature has taken place.

The increasing boiler pressures would scarcely have been obtainable within practical weight limits had there not been available alloy steels, the superior tensile strength of which could be utilized to withstand the higher stresses without increasing the weight. The nickel and silicon steels which were first employed about 12 years ago are now almost universally specified for the boiler shells of new locomotives and, to a considerable extent, for outside wrapper sheets as well.

The possibility of a reduction in boiler weights and perhaps also an increase in durability awaits the removal of the present restrictions against welding. Whether or not these restrictions can be removed with reasonable safety depends on the outcome of the experimental period of service with the Delaware & Hudson all-welded boiler. Whatever the outcome of this experiment may be, there seems little doubt but that ultimately a technique will be



Timken roller bearings in a one-piece housing

developed which will permit the practical attainment of the advantages of improved balance in the design and reduced weight which the application of welded construction offers.

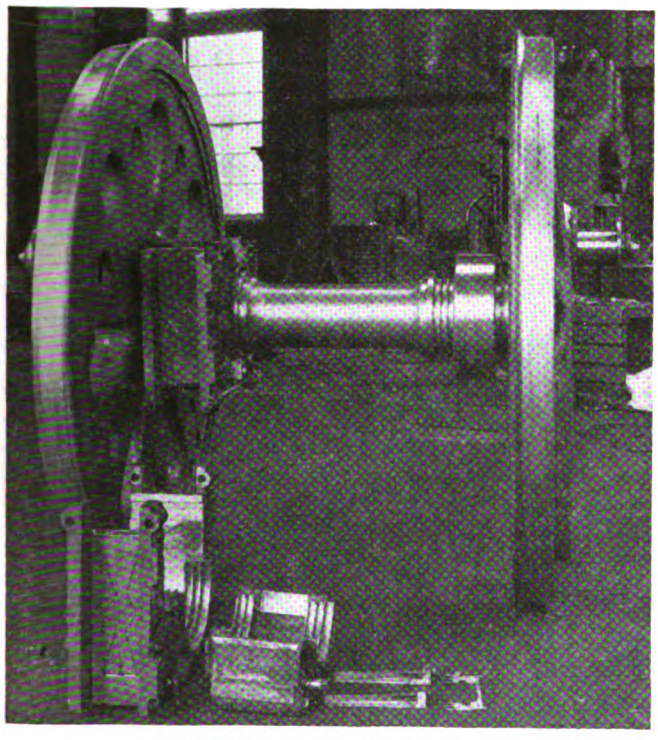
The general adoption of welding for inside firebox construction has, to a considerable extent, mitigated the difficulties experienced with earlier combustion-chamber fireboxes. It has further removed the restrictions on the inclusion of the combustion chamber and has made more widely available the better relationship of firebox volume to grate area which the combustion chamber provides. This is of significance in the matter of heating-surface distribution and also forms an important factor in the sequence bearing directly on combustion efficiency.

The application of Thermic syphons has also been gradually extended to include the combustion chamber as well as the firebox. Renewed interest in firebox circulation is becoming evident in the development of several new types of circulating mediums built into the firebox.

So far as possible within practicable limits increasing attention has also been paid in recent years to the direct relationship which should exist between gas areas through the boiler and grate area, and to front-end proportions. Attention has been directed to these important factors since the successful employment of the pin-hole grate for burning various grades of lignite completely upset long-established ideas with respect to air openings through

the grates. In the matter of grates, themselves, types are available by which improved distribution of air through the fire bed is effected. Grates are also available which permit the burning of bituminous slack with practically no ash-pan loss.

All of these factors combine to make the modern locomotive boiler a much more highly efficient steam generator and the locomotive a much more intensive producer of power than that of even 10 to 15 years ago. The largest horsepower output per driving axle of the locomotives tested at the St. Louis exposition in 1904 did not exceed 400 i. hp. About 10 years ago this had risen to about 1,000 i. hp. The tests of the new J-3 class 4-6-4 type passenger locomotives on the New York Central have shown an indicated horsepower per driving axle of almost 1,600. Designs are being considered at the present time contemplating a further substantial increase. These are all passenger locomotives. Although



SKF roller-bearing driving box

figures for freight locomotives in themselves are less impressive, the trend is of the same order.

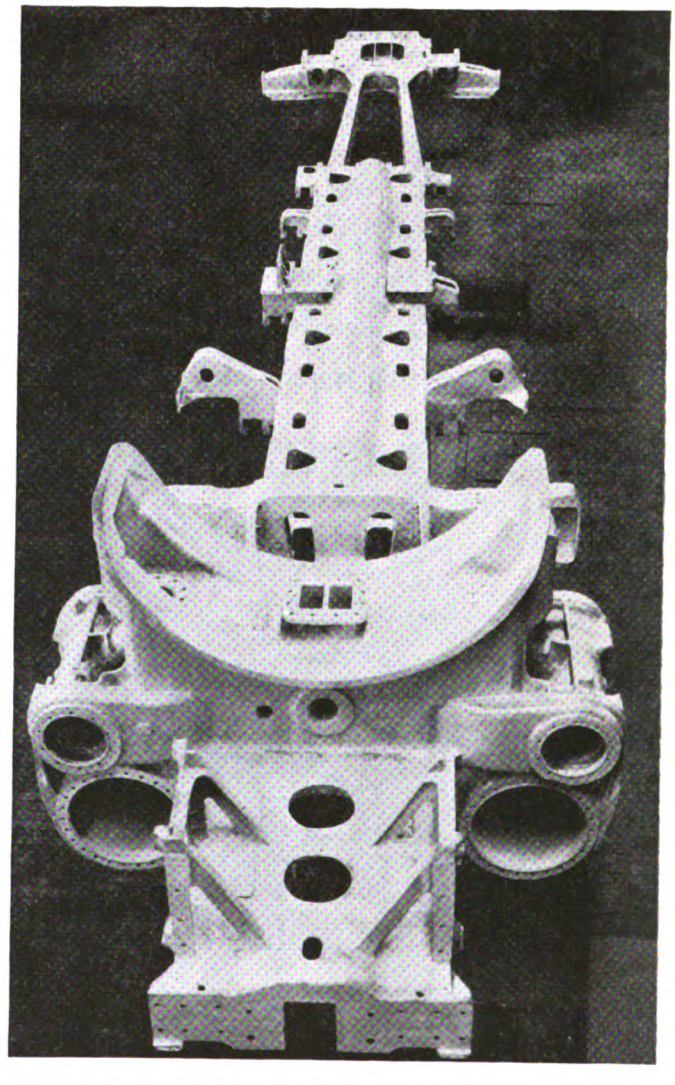
Better Balance and Increased Stamina

The higher horsepower for which the modern boiler has been able to supply steam has called for numerous improvements in the entire structure and mechanism of the locomotive. This begins with the cylinders and several segmental packings have been developed to keep down cylinder wear as well as to maintain a reasonable life of the packings, themselves.

In passenger locomotives the increasing concentration of horsepower output has been utilized to produce higher speeds. This has called for a complete reconsideration of reciprocating-part design and counterbalancing. Notable reductions have been effected in the weight of reciprocating parts in some of the recently built locomotives and greater care is being given to counterbalancing. For some years the employment of cross-balancing in the main wheels has been extending. In some recent designs for high speeds this has been extended to all of the wheels.

Not only has the increase in horsepower per axle been accompanied by increased loads on rods, pins and axles, but the increased speeds at which these horsepowers are developed has resulted in an even greater increase in the loads on running gear resulting from track reactions. Such forces tend to increase as the square of the velocity of the locomotive; hence, materially increasing the influence of this important factor in running-gear and frame design. The use of lateral-control devices has been extended. In at least one passenger-locomotive design the lateral is cushioned on the main, as well as on the front and back, drivers.

One of the outstanding qualities of the modern steam locomotive is its increasing mechanical reliability in spite of the increasing severity of working loads to which it is subjected by modern operating conditions. One of the factors producing this result is the bed casting. Despite the earlier fears as to the employment of cast metal in such large units and some early failures, the balanced distribution of metal characteristic of the later designs has removed the cause of most failures and repairs are readily made by welding when need arises. So great has been the increase in the stresses to which the foundation is subjected in modern locomotives of high horsepower capacity that frames on locomotives of otherwise modern design have been replaced by bed castings, in some cases within a few years of their original construction.



The cast-steel underframe is the foundation of the modern high-capacity steam locomotive

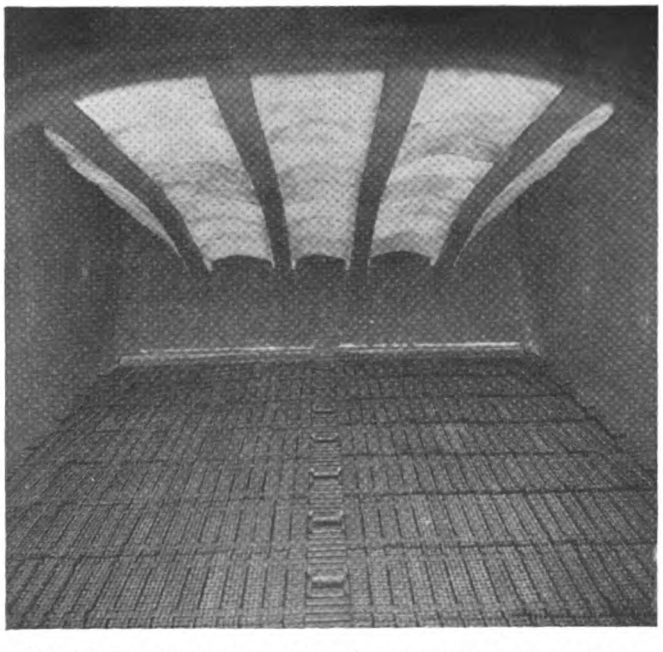
The new types of cast-steel driving wheels which are now rapidly replacing the old wheels with spokes of simple oval sections are a further development to meet the demands of the increasingly severe loads to which the locomotive running gear is subjected. They have also materially improved the possibilities of effecting adequate counterbalancing.

Close Tolerances and Controlled Flexibility

The roller bearing, particularly its application to driving boxes and, more recently, to crank pins, has inaugurated a revolution in ideas concerning the mechanics of the steam locomotive in America. Throughout the history of locomotive development in this country great weight has been given to the maintenance of the locomotive as a highly flexible vehicle. With the usual type of crown and sleeve bearings this flexibility has been maintained by employing large tolerances—extremely large tolerances if measured in terms of any other type of machine—in all running-gear bearings. A European visitor to America, observing this practice, once said: "Your locomotives are half worn out when they come out of the shop."

The very life of the roller bearing requires the maintenance of close tolerances in all fits relating to it to keep shocks below the danger point. The greater durability, not alone of the fits of the roller bearings themselves, but also of other fits which determine important alignments throughout the machine, which has been demonstrated on locomotives fitted with roller-bearing driving boxes and rods, is a revelation of a new era in locomotive reliability. Close tolerances in working fits and controlled movement where flexibility is essential promise much in reduced rates of wear and deterioration of the entire mechanism of the locomotive.

Along with the increased attention to working fits in the locomotive there has been a refinement in lubrication methods. The engineman's oil can has been almost completely replaced by the mechanical lubricator or the grease gun. Mechanical lubrication is being applied on new locomotives to guides, shoes and wedges, and hub liners. The automatic oil lubrication of engine-truck, trailer-truck and driving axles is also finding its way into the picture. The increasing application of pressure grease lubrication and of roller bearings to valve-motion pins, as well as the systematic lubrication of such parts as spring rigging and brake rigging, long quite generally neglected, is further evidence of the evolution of the steam locomotive into a fine mechanism.



Loose fingers, improved air distribution and reduced ash-pan losses characterize modern grates

Tender Trucks

The development of the tender to meet increasing coal and water capacities and the more severe problems of riding which greater speeds of both freight and passenger trains have caused has scarcely been less striking than the many improvements in the development of the locomotive, itself. The riding of tenders has constituted a frequently recurring problem for many years. The present trend in tender-truck design is approaching that of the passenger car, so far as the weight suspension is concerned. In fact, the tenders of at least one recently built order of locomotives are carried on Pullman trucks. The most recent development is the eight-wheel truck employed on the new locomotives delivered by Baldwin to the Atlantic Coast Line to carry tenders with a capacity of 27 tons of coal and 24,000 gallons of water, which are 48 ft. long.

The corrosion-resistant qualities of some of the low-alloy steels are being utilized in tank construction for their possible value in future reductions of maintenance.

The Economic Value of the Modern Steam Locomotive

This article has suggested the more important developments in the proportions and equipment of modern locomotives which account for their high economic value. There are two aspects of that value. What high capacity means has already been suggested. A familiar instance was the return of 38 per cent in the first year on the investment in some 20 modern high-capacity freight locomotives on the Lehigh Valley by which trains of 3,000 to 3,500 tons were handled over the road at from 10 to 15 per cent higher speeds than the 2,000 to 2,500-ton trains handled by the older power replaced in through main-line service. In addition to the saving in train-miles, higher fuel efficiency and reduced helper service were among the items contributing to the highly satisfactory financial result.

The other aspect of the economic value is the effect of the installation of modern locomotives on maintenance. In one case a group of modern freight and heavy passenger locomotives which constitute about 5 per cent of the locomotive ownership, the oldest of which are seven years of age, last year made approximately one quarter of the total locomotive mileage and approximately one half of the freight-locomotive mileage. These locomotives proved capable of making from 250,000 to 275,000 miles between shoppings, whereas other classes of older locomotives in freight service were able to stay out of the shops for Class 3 repairs for but little more than 100,000 miles.

In another case several classes of relatively new locomotives, constituting less than 30 per cent of the ownership, were responsible for over 50 per cent of the total road locomotive-miles in freight and passenger service. Last year, compared with 13 years ago, the cost of repairs per locomotive-mile showed a reduction of nearly 16 per cent in spite of increased cost. A part of this result may, no doubt, be attributed to the fact that the average miles between shoppings had about trebled within that period. Such results are due in part to the greater reliability and stamina of modern locomotives to meet modern operating conditions and partly to the tendency after the first two or three years of unit maintenance costs to increase steadily as the age of the locomotive increases.



Santa Fe streamliner built by Electro-Motive and Budd

Travel Patrons Being Won by

Style – Comfort – Speed

New equipment designed for maximum passenger appeal also proves helpful in making the general public "railroad conscious"

PASSENGER revenues of Class I railroads in the first three months of this year totaled $99,804,054, a decrease of $5,602,600 compared with $105,406,654 in the same period last year, but an increase of $3,283,872 compared with the corresponding 1936 period. The increases over earlier years are even more marked, being $14,368,311 over 1935; $19,787,907 over 1934; and $27,612,543 over 1933. The substantial improvement in passenger revenues since 1933 strongly indicates the important part modern passenger equipment has played in gaining and holding passenger traffic for the railroads.

Among various factors affecting the volume of railroad passenger traffic, the following may be listed in the approximate order of their importance: Safety, cost, styling, comfort and speed. Safety is so fundamental and generally associated with rail travel that it is more or less taken for granted. Next to safety, cost is probably the most influential single factor in mass passenger transportation. In other words, the best way to stimulate increased passenger traffic is to offer the service at rates which can be readily paid by a larger portion of the population. Styling, comfort and speed are vital features of any equipment designed to appeal to the modern traveling public, but the relative value of these three characteristics cannot be definitely and conclusively stated because, under certain circumstances, each is a primary consideration.

The importance of all of these elements of appeal in modern passenger equipment is amply demonstrated by results with the new lightweight streamline trains, 66 of which have been built and placed in service on 18 railroads throughout the country. The resultant increase in passenger traffic is difficult to determine accurately, but traffic managers say that more or less careful checks indicate the addition of roughly 20 per cent new business when these modern trains are installed. Evidently the styling feature first attracts prospective passengers and the comfort and speed features stimulate repeat business.

In addition to gaining and holding passenger traffic, as suggested in the opening paragraph, the new trains must be largely credited with a notable change in public sentiment favorable to the railroads. The trains attract thousands of sightseers daily on their initial advertised exhibition tours and, even after being in service many months, crowds gather at crossings to watch the more spectacular high-speed streamliners go by. It can hardly be questioned that a substantial part of the relatively high first cost of these trains may be charged to publicity since the trains have made thousands, if not millions, of people "railroad conscious" to an unusual degree and convinced them that modern railway managements are, in fact, alert, progressive and up-to-date.

Interior and Exterior Styling Receive Attention

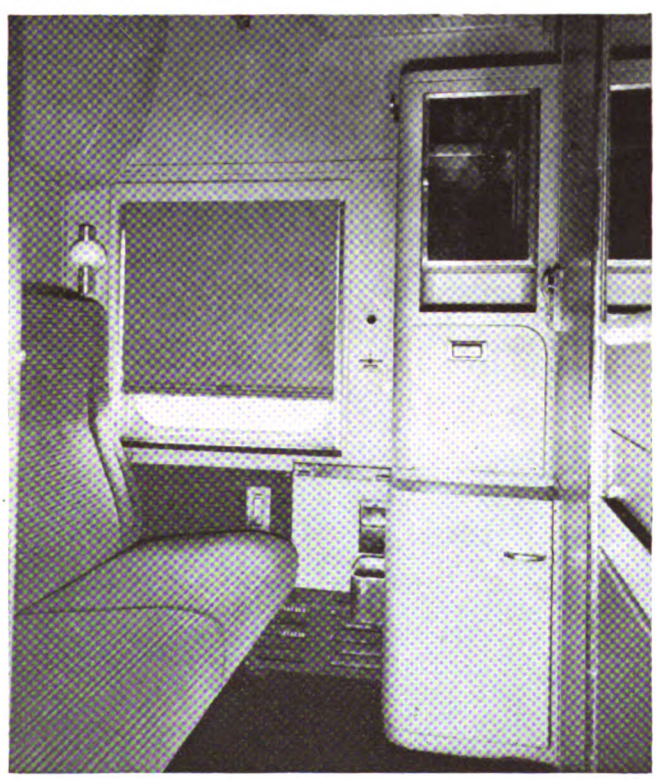
Aside from new and rebuilt equipment installed within the last two or three years, the supply of railway

passenger cars is largely obsolete and inadequate with respect both to attracting passenger traffic and impressing the general public. Since the introduction of air-conditioning in 1930, a complete revolution has taken place, not only in the materials of construction and ideas with respect to weight in its relation to strength in passenger-car design, but also in the comfort of interior facilities and attractiveness of architectural and decorative treatment. Style factors, both interior and exterior, are beginning to receive and must continue to receive the serious attention of railway managements in attempting to attract patronage because the American people are becoming more and more style conscious and more and more fastidious with respect to personal surroundings.

Car exteriors have been styled to accentuate the idea of speed and an entirely new conception of comfort, cleanliness and attractiveness is apparent in car interiors. The change from suction to pressure ventilation introduced with air conditioning has removed the barriers which dirt imposed upon a free choice of color tones and the softening of interiors by the hanging of drapes. The design of interior architectural features and decorative treatment, formerly a function of the engineer, who selected his colors for their ability to make dirt as nearly invisible as possible, has passed to the trained artist with results in public reaction which were immediately favorable.

It may also be said that improved lighting has played an important part both as a comfort factor and as a decorative feature. In the new and refitted cars alike new ideas with respect to light distribution and light intensity are being carried out with a notable degree of success from the point of view of passenger appeal.

Only one caution need be observed and that is to exercise a reasonable degree of supervision over the consulting architect and expert interior decorator who, without some check, are almost sure to go further than necessary in covering up working parts with streamline shroudings and suggesting the use of delicate color schemes, upholstery fabrics, etc., which will not stand the rigors of railway service. In other words, a stiff price must be paid for modern styling, and good judgment is required to keep both the first cost and subsequent maintenance cost within reasonable limits.



Interior appointments in one of the new Pullman Roomette cars

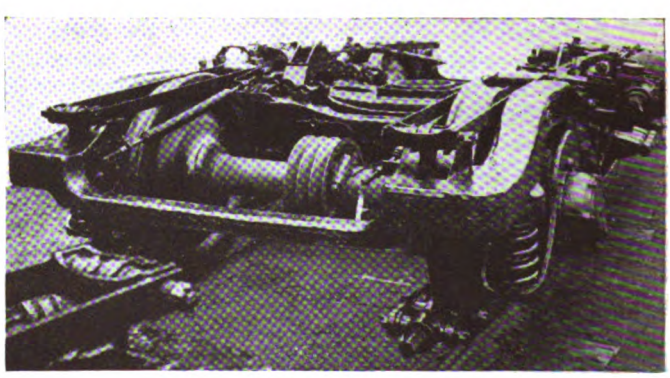
Notable Improvements Effected in Riding Comfort

From the point of view of passenger comfort and convenience, modern passenger cars are so far superior to those of only a few years ago that there is no real comparison. Doubtless the greatest single improvement along this line is the development and general application of air conditioning which has taken place since 1930. According to a report just issued by the Association of American Railroads, Class I railroads and the Pullman Company had 10,417 air-conditioned passenger cars in service, as of April 1, 1938, an increase of 2,149 cars over the previous year. Of this year's total, 5,583 cars were owned and operated by the railroads and include coaches, dining cars and other types of passenger equipment, while the Pullman Company had 4,834 air-conditioned passenger cars in service, including sleeping cars, lounging cars, and other passenger equipment.

In general, four different types of air-conditioning equipment are installed, including electro-mechanical, direct-mechanical, ice and steam ejector, each of which has individual advantages in particular applications. Two problems, which may have been solved in advanced designs not yet generally adopted are the question of proper air distribution and the elimination of odors. An air-conditioned car is worse than useless for the purpose intended when cold drafts strike any part of the passenger's anatomy, or if, as sometimes happens, the recirculated air carries objectionable body and smoke odors.

No part of modern passenger-car design has received more intimate study than the trucks. While track conditions are a limiting factor in both the ridability of cars and the permissible speeds attained, real progress has been made in developing truck designs adopted to produce maximum ease of riding. Cylindrical-tread wheels are now used on many of the lighter trains; unsprung truck weight is minimized; special spring suspensions, sometimes incorporating rubber supporting pads and used in conjunction with hydraulic shock absorbers, effectively cushion rail shocks; truck-mounted brake cylinders with modern clasp brakes contribute to smoother brake applications.

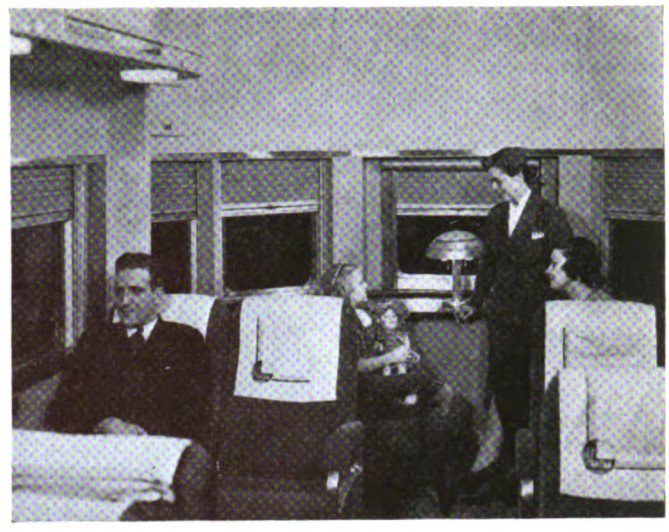
Other mechanical improvements with a bearing on passenger comfort include the provision of tight-lock couplers and modern draft gears, sometimes of the rubber mat type, to minimize shocks in train handling; dia-



Modern lightweight alloy cast-steel truck equipped with roller bearings



The rotating reclining back seats are a feature of today's passenger equipment



Pleasing interior decoration and arrangement characterizes the Santa Fe's El Capitan

phragm and buffer applications designed with a judicious use of fibre bushings and wearing parts to reduce noise; and the provision of sealed windows and adequate thicknesses of modern insulating materials which have obvious advantages.

Car interiors are the "last word" as regards passenger comfort and convenience, and there is some question if the railroads have not gone too far in providing all of the appointments of the finest private club which necessarily add appreciably to the unit car cost and, therefore, reduce the number of modern cars which can be placed in service.

No defense is necessary for the comfort features, pure and simple, which are very important in keeping the public "sold" on rail transportation. Modern seating, washroom and lounge facilities are fundamental requisites. Rotating, reclining-back coach seats, as well as special lounge chairs, now largely designed with rubber cushions, represent a real contribution to riding comfort. Lunch room and dining car service have attained new standards of excellence, combined in many instances with relatively low cost. The improvements in and added variety of sleeping-car accommodations and facilities provided by the Pullman Company for the comfort and convenience of passengers are too extensive to be even listed in this article.

Increased Speeds Are Here to Stay

With maximum speeds in excess of 100 miles an hour, average speeds of 70 miles an hour for relatively short non-stop runs up to 100 miles, and average speeds of 65 miles an hour for runs up to 1,000 miles, it is apparent that the trend of railroad passenger train speeds is persistently upward. The public, in general, demands these speeds, and what the public wants it will get in this case, even though there is little knowledge or appreciation of what supertrain-speeds mean to the railroads in the way of increased operating and maintenance costs.

To the great credit of railroad managements, equipment designers, operating men and maintenance forces be it said that no major accident has happened to any of the high-speed passenger trains placed in service during the past three years and, in fact, so far as can be learned, no passenger has suffered a personal injury. Needless to say, all railroad men are profoundly thankful for this good fortune and fully determined to exercise every precaution in maintaining such a remarkable safety record intact.



Stainless steel dining car interior on the Burlington's Aristocrat

To keep the power demands of high speeds within economical limits light weight is essential and, since 1934 especially, there has been an intensive development in the application of aluminum alloys, stainless steel and low alloy, high-tensile steels to passenger-car construction. The light weight has been accompanied by streamlining which, if not of controlling importance, aerodynamically speaking, has been a potent style factor, as mentioned. As a practical matter, probably the bringing out of windows almost flush with the car sides, removal of projections and general smoothing of car exteriors has provided the greatest net reduction in air resistance. The shrouding of trucks has helped to a limited extent

and head-end lines have some bearing, particularly on short trains. On long trains, however, reduced air resistance due to so-called streamlining is a small factor compared to other elements of train resistance.

Fabricating methods used in building the new passenger cars represent a great improvement over former practice, the major difference, in the case of all steel cars, being the more extensive use of welding. Both manual and automatic arc welding and spot welding offer the modern car builder a fabricating tool which he has not been slow to use. Material has been saved, design simplified, rivet holes reduced in number or eliminated, and welded joints produced stronger than the parent metal.

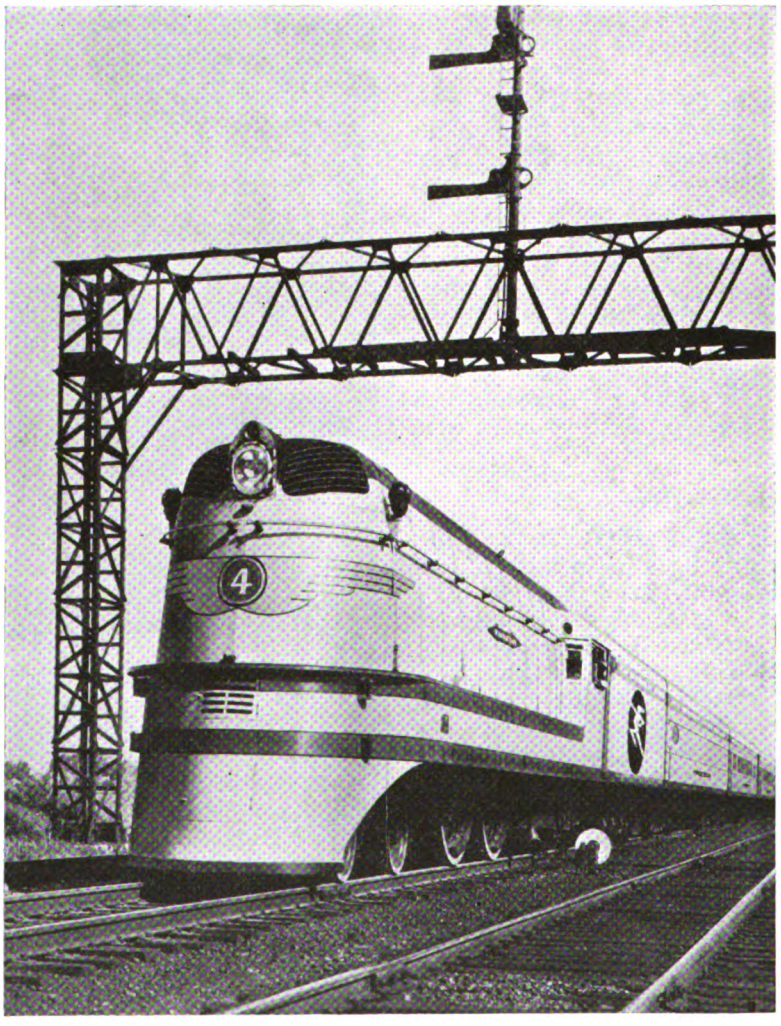
In general, it may be said that passenger-car weight can be reduced roughly one-third and at small increase in cost by the use of welded high-tensile low-alloy steel construction. If further weight saving is desired, a total reduction of 40 to 45 per cent from conventional car weights can be secured at a moderate increase in cost by the use of aluminum-alloy, or shot-welded stainless-steel construction.

The problem constantly confronting the car designer is how to avoid losing what he saves in reduced car-shell weight by what he puts in the cars and hangs on the trucks. In a recent light-weight welded-steel coach design, for example, the car shell weighed 25,868 lb.; the car body, 75,000 lb.; the two trucks, 37,960 lb.; and the total car, 112,980 lb. Part of this rather striking build-up in the total car weight was due to the use of relatively heavy floor construction, partitions and doors, a self-contained gas engine-generator set for air conditioning and trucks of somewhat heavier than average construction. Attention to all of these details, including car couplers, draft gears, truck castings and brake equipment made of high-tensile steel at some premium in cost is essential for maximum results in weight reduction.

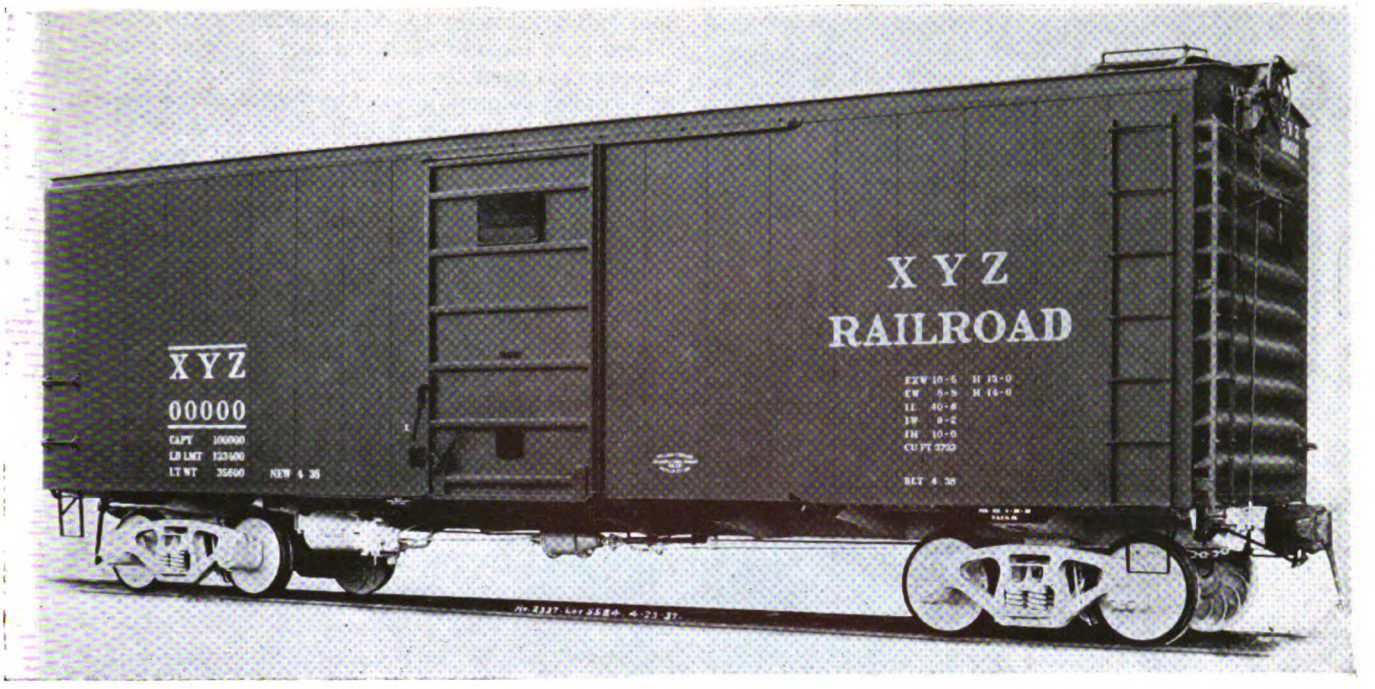
Two problems which still give some trouble in connection with ultra high-speed train operation are braking and wheel performance. In the interests of safety, the ductility of the steel truck wheels has been kept relatively low with resultant somewhat limited service life. High braking ratios and shoe pressures at high speeds also contribute to wheel wear. While the brake companies' high-speed brake equipments are designed to reduce shoe pressures and avoid wheels sliding to a stop, some trouble is still experienced in this particular and the indications are that, for this particular service, an auxiliary positive-acting device will have to be developed and applied to prevent wheel sliding.

The latest and most extensive installation of modern passenger equipment is that of the New York Central and the Pennsylvania, each of which is placing in service on June 15 complete new equipment for the Century and Broadway train operation between New York and Chicago. A total of 52 new Pullman cars is now being delivered to each of these roads.

Other programs of passenger equipment rehabilitation are under way, and the public reaction to modern cars and trains is so unmistakably favorable that the railroads are bound to continue the work so effectively begun.



The Milwaukee's new Hiawatha



An all-welded box car built by Pullman-Standard having a light weight of only 35,600 lb.

Less Weight—More Reliability—Feature

Modern Freight Cars

New designs utilize mostly high-tensile steels, in conjunction with more or less welded construction

SINCE 1935, over 16,000 lightweight freight cars have been built for service on American railroads incorporating for the most part low-alloy high-tensile steel construction and including such commonly used types as hopper cars, gondolas, refrigerators, box and automobile box cars. A feature of these cars has been the more or less extensive use of welding and the development of well-balanced designs adapted to give long and satisfactory service under the exacting conditions of modern high-speed operation. In addition to the steel cars, a limited number of special-service hopper cars and tank cars have been constructed of aluminum alloys, the resultant saving in weight, however, being essentially secondary to corrosion resistance in handling such commodities as high sulphur coals, acids, etc.

The possibilities in the way of weight reduction, utilizing modern materials and fabricating methods, are well illustrated in the table giving the general dimensions and weights of three typical 50-ton box cars, as compared to the latest A. A. R. standard design of 1937, which itself represents a saving of about 3,000 lb. over earlier designs in general use. Referring to the table, it will be noted that the A. A. R. car, embodying primarily riveted, carbon-steel construction, weighs 45,300 lb.; the Union Pacific 1937 car, built mostly of Cor-Ten steel by a combination of riveting and welding, weighs 39,000 lb.; the Mt. Vernon car, built in 1935 of Cor-Ten steel with riveted construction throughout, weighs 36,400 lb.; and the Pullman-Standard car of 1937, also built of Cor-Ten steel, but fabricated almost entirely by arc- and spot-welding, weighs 35,600 lb. These cars show a progressive increase in load limit and consequent ratio of load limit to maximum weight on rails from 73 to 79 per cent. Service tests, as well as impact tests, conducted by the A. A. R., Division of Equipment Research, have shown that even the lightest of these cars is essentially a sound structure.

How to Evaluate the Savings from Lightweight Cars

One of the most recent discussions of economies possible by the use of lightweight equipment, presented by O. Jabelmann, assistant to the president in charge of research, Union Pacific, before the Trans-Missouri-Kansas Shippers Board, at St. Louis, Mo., September 21, is so much to the point that it is quoted as follows:

"In taking up the economic possibilities of a lightweight freight car there are three principal items of possible savings:

"1—Saving in operating costs due to reduced tare weight.

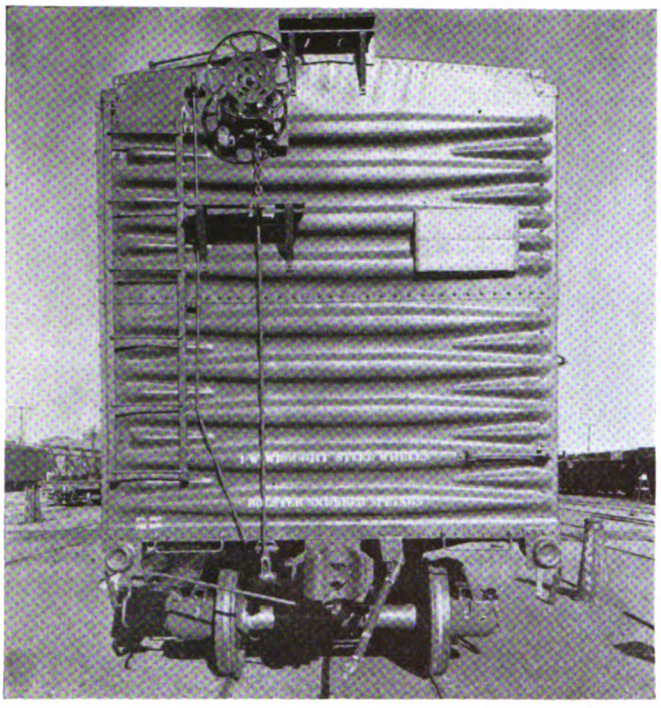
"2—Saving due to increased available capacity of car.

"3—Saving or loss in maintenance cost.

"The one item of loss in building the lightweight car is the increased initial cost as compared to the cost per unit of the conventional car, which can be readily estimated.

"Taking up the three possible savings:

"First, there can be figured in advance a definite saving in operating costs of the lighter weight car over a standard design due to reduced weight.



End view of one of the most recent designs of light weight box car

"Second, the saving due to the increased capacity of the car is possible only when the cars are loaded to their load limit. This condition occurs only a portion of the time in the case of box and automobile cars, and we would like to think of this as more of an available convenience than to itemize it as an actual saving in dollars and cents. This item is of greater importance in open-top cars which can most always be loaded to their load limit except when carrying light bulky material.

"Concerning the third item, maintenance cost of a lightweight alloy steel car, as compared to the standard type. We believe the only real way of determining this expense or savings would be to keep an accurate record of a number of lightweight cars over a period of several years, then average this cost and compare with the average expense of maintaining the standard car for the same period of time. Because of the lack of reliable information on this subject, we have assumed the cost of maintaining the two types of cars to be the same. We believe the possible longer life resulting from the use of the higher-strength steels offsets to some extent the greater cost of such materials when replacements are necessary. Any superior resistance to corrosion that high-strength steels possess may be offset, at least in part, by the fact that the structural shapes and sheets used in lightweight construction are thinner.

"A much discussed figure used in formulas on freight-car economy is the portion of total cost per ton-mile of moving freight-car rolling stock. We will assign the letter e to this variable. Regarding the value of e, there seems to be considerable difference of opinion.

"A value of $.00170 per gross ton-mile is given on page 152 in the 1935 Report of Mechanical Advisory Committee to the Federal Coordinator of Transportation. This figure was obtained by taking the total direct freight-car operating expenses, including repairs to equipment from the selected accounts, for the year 1930, of five N. Y. C. lines, totaling $139,758,884. This amount was divided by the gross ton-miles, exclusive of locomotives, of the same five lines, totaling 82,037,253,000. This value $.0017 can be used only when figuring the saving made by weight reduction of cars that are most always loaded to axle capacity or their load limit. These cars include open top cars, such as gondola and hopper cars used for hauling coal, iron ore, sand, gravel and similar commodities. On the following page of this report is listed under Group 1 the accounts to be considered as operating expenses when obtaining a value of cost per gross ton-mile to be used in economy figures for cars not ordinarily loaded to their load limit, such as box, automobile and furniture cars. Using lightweight cars in this class of service would not necessarily reduce the number as compared to using conventional cars. When taking this into account the e figure obtained is reduced to $.000846 per gross ton-mile.

"A figure of $.001715 per gross ton-mile is computed from information given in an article by A. F. Stuebing, railway mechanical engineer, United States Steel Corporation, which appears on page 339 of the Railway Age of September 2, 1933. This is obtained by dividing the estimated total annual savings for a reduction of one ton in the weight of the car by the average annual freight car mileage. ($17.97 ÷ 10475 = $.001715).

"In a recent advertisement of the United States Steel

Comparative General Weights and Dimensions of Several Lightweight 50-Ton Box Cars of Recent Design

	New 1937 A. A. R. standard	U. P. 1937 H. T. steel design	Mt. Vernon 1935 design H. T. steel riveted	Pull. Std. 1937 design H. T. steel welded
Inside length, ft.—in.	40—6	40—6¼	40—6	40—6
Inside width, ft.—in.	9—2	9—2	8—9	9—2
Inside height at eaves, ft.—in.	10—0	10—½	9—4	10—½
Cubic capacity, cu. ft.	3,711	3,730	3,316	3,712
Light weight of car body, lb.	29,700	25,550	22,740	21,000
Light weight of trucks, lb.	15,600	13,450	13,660	14,600
Total light car weight, lb.	45,300	39,000	36,400	35,600
Load limit, lb.	123,700	130,000	132,600	133,400
Maximum weight on rails, lb.	169,000	169,000	169,000	169,000
Ratio $\frac{\text{load limit}}{\text{Max. wt. on rails}}$	.73	.77	.78	.79

Corporation it is stated, '$18.00 is the carefully estimated average annual cost of hauling one ton of dead weight in freight car equipment.' This $18.00 value, undoubtedly, corresponds to the $17.97 mentioned in the 1933 article. Also, quote: 'In the 8,800 new lightweight freight cars, built of USS Cor-Ten in the last 2½ years, tare weight has been reduced 20 per cent and more. An average of four tons per car has been trimmed off, giving capacity for as much additional pay load. Revenue per car has been increased 6 per cent to 8 per cent with no increase in operating expense.'

"Let us now work out the economy of a particular lightweight box car, such as the Union Pacific 1937 design, as compared to a conventional box car weighing 45,100 lb. Assume that these cars are to be loaded to their load limit 90 per cent of the time. This will allow us to use the high value for e = $.0017 per gross ton mile.

Let W_1 = weight of conventional box car ..... 45,100 lb.
W_2 = weight of U. P. 1937 lightweight car ..... 39,000 lb.

then $W_1 - W_2$ gives a reduction in weight = ... 6,100 lb.

"Assuming an increase in cost of light-weight car over conventional car of $300, then the cost per pound of weight saved $= \frac{300}{6,100} =$ $.049, or 5 cents per lb.

Let t_1 = Tax rate = ... 1 per cent
t_2 = Interest assumed = ... 3 per cent
t_3 = Depreciation rate (25 years) = ... 2.74 per cent

t_4 = Total fixed charge rate = ... 6.74 per cent
M = average annual mileage per box car on U. P. Lines = 10,000 miles

The operating expense saved per car per year =

$$M \frac{(W_1 - W_2)}{2,000} e = 10,000 \frac{6,100}{2,000} \times .0017 = \$51.85$$

"From this amount each year the fixed charges are paid and the remainder, which is the net saving, may be invested at t_2 compound interest.

Fixed charges = t_4 (300) = .0674 × 300 = $20.22
The net savings per car per year = S = $51.85 — $20.22 = $31.63
The net savings per car in 25 years would be

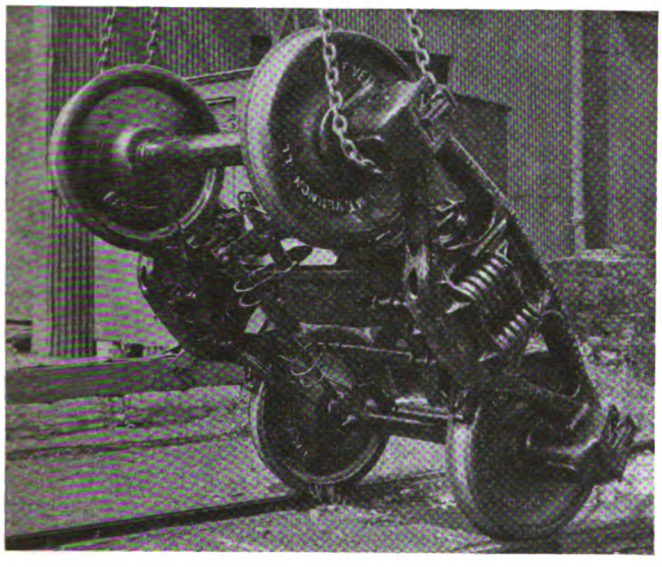
$$G = S \frac{(1+t_2)^n - 1}{t_2} = 31.63 \frac{(1+.03)^{25} - 1}{.03} = \$1,153.17$$

"By equaling the operating expense saving and the fixed charges we can determine the cost per pound that could be paid for weight saved, in other words, the cost that just balances the saving and fixed charges as follows:

$$M \frac{(e)}{2,000} = t_4 C, \text{ or } C = \frac{M\,(e)}{t_4 \times 2,000}$$

$$C = \frac{10,000 \times .0017}{.0674 \times 2,000} = .126 \text{ or } 12.6 \text{ cents per lb.}$$

"This figure is of value when considering the cost



Underside view of a modern lightweight spring plankless truck

paid per pound of weight saved for either the total car or break down detail parts of the car under consideration."

Increased Reliability in Freight Cars of Recent Design

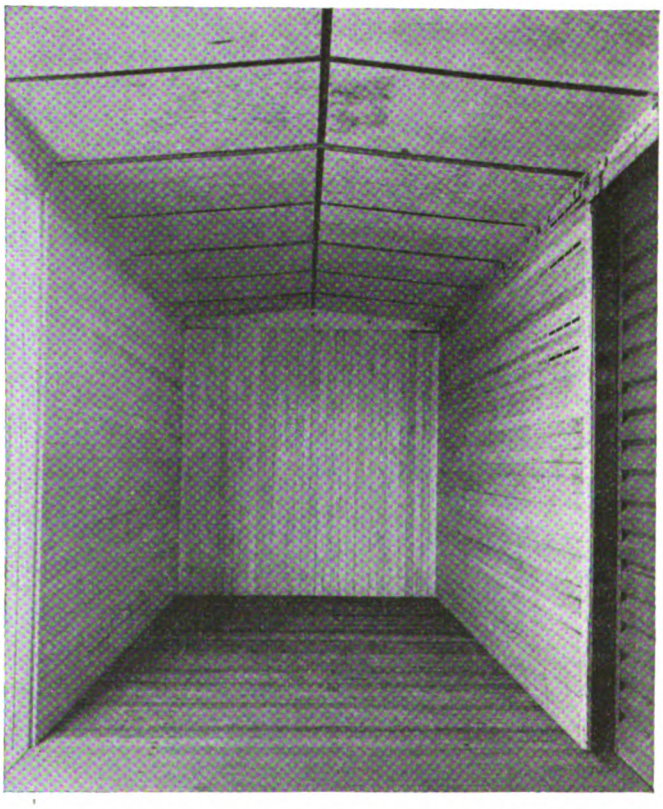
With the advances which have been made in materials and engineering design, the new lightweight freight cars represent a distinct improvement over earlier types, not only from the standpoint of weight saving but from that of increased reliability and freedom from service failures. This applies equally to the car bodies, which in general are designed to avoid peak stresses by the scientific application of extra material where needed, and also to the trucks which, by elimination of the spring planks, provision of lightweight wheels, high-tensile steel bolsters, side frames, etc., may be designed with a saving of roughly two tons in weight per car set and yet afford a simple, flexible and strong construction assuring years of service with little likelihood of failure.

While it must be admitted that the lightweight alloy-steel cars have been in service hardly long enough to give full information regarding maintenance costs, the indications are that more or less appreciable savings will be effected in this important particular. In general freight-car service, therefore, it is not unreasonable to suppose that the new high-tensile steels will show as much greater resistance to corrosion than copper steels, as the latter show when compared with plain carbon steels. The greater resistance to abrasion and physical abuse which is afforded by high-tensile steels is also favorable to a good maintenance showing.

Another factor of importance is the welded construction used more or less extensively in modern lightweight freight cars, especially when maximum weight saving is a prime consideration. Welding technique and equipment of both the manual and automatic type have been developed and improved to such an extent that unusually reliable results are being secured. A recent A. A. R. report for example, covering impact tests up to 13 miles an hour of a box car fabricated almost entirely by arc and spot welding, showed no defects, and a close inspection of 14,000 spot welds failed to disclose any indication of weakness or failure.

The welded seams and connections not only avoid overlapping construction, but make possible simplifications in design which effect substantial weight savings. In addition, there are no punched rivet holes to reduce the effective cross sectional area in tension and thus necessitate using slightly heavier sections. As regards the general efficiency of a welded joint or seam between two pieces of metal, modern welding practice permits developing the full strength of the original metal parts being joined, or more if necessary.

Still another important advantage of welding, in its bearing on car maintenance is the possibility of positively sealing exposed joints against water leakage and resultant accelerated corrosive action, especially when products such as high-sulphur coals are being hauled. This fact is well demonstrated in the case of five welded hopper cars built in 1931 for the Chicago Great Western by the Pullman-Standard Car Manufacturing Company, these cars having been remarkably free from deterioration or the necessity of repairs during a period of six years in which they have been assigned largely to the



The interior of this car shows evidences of good design—Plywood has been used for the inside roof lining

hauling of Southern Illinois coals with a relatively high sulphur content.

Cars Must Be Designed and Equipped for High-Speed Operation

The statement that average freight-train speeds increased from 11.9 miles an hour in 1926 to 16.1 miles an hour in 1937 does not give a real picture of what is happening. The fact is that many manifest freight trains are being operated on practically passenger train schedules, and speeds of 50 or 60 miles an hour are by no means uncommon. This means that modern well-maintained draft gears must be installed to cushion shocks in train handling and, even more important, adequate brake equipment provided to permit stopping long heavy trains safely from high speeds within the required distances. The flexibility, uniformity and reliability of brake applications with the new Type AB freight brake make its general application highly desirable and, if the present tendency towards higher train speeds, in conjunction with higher ratios of load limit to light car weight, is maintained, the empty-and-load brake feature will become a necessity. Savings in car maintenance as a result of smoother brake action are offset to a certain extent by increased cost in repairing the somewhat more complicated AB brake equipment, but there will be an important net saving in lading damage and attendant claims.

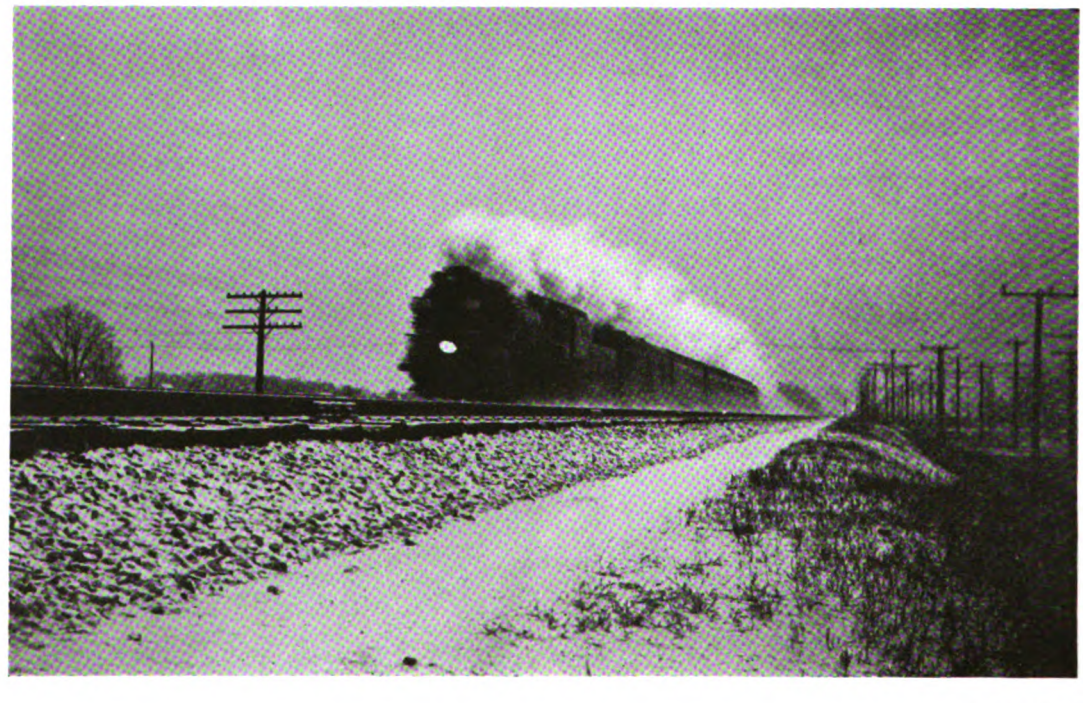
Next to adequate brakes in contributing to safe operation and the reduction of damage claims is the freight car truck which must provide not only maximum reliability and freedom from maintenance difficulties, but easy riding qualities far in excess of those required when freight train speeds seldom exceeded 30 to 35 miles an hour. Concentric wheels, better spring maintenance and modern truck stabilizing and spring snubbing devices seem to be essential requirements for all cars used in the shipment of commodities which may be damaged by excessive vertical oscillation at critical speeds above those formerly attained.

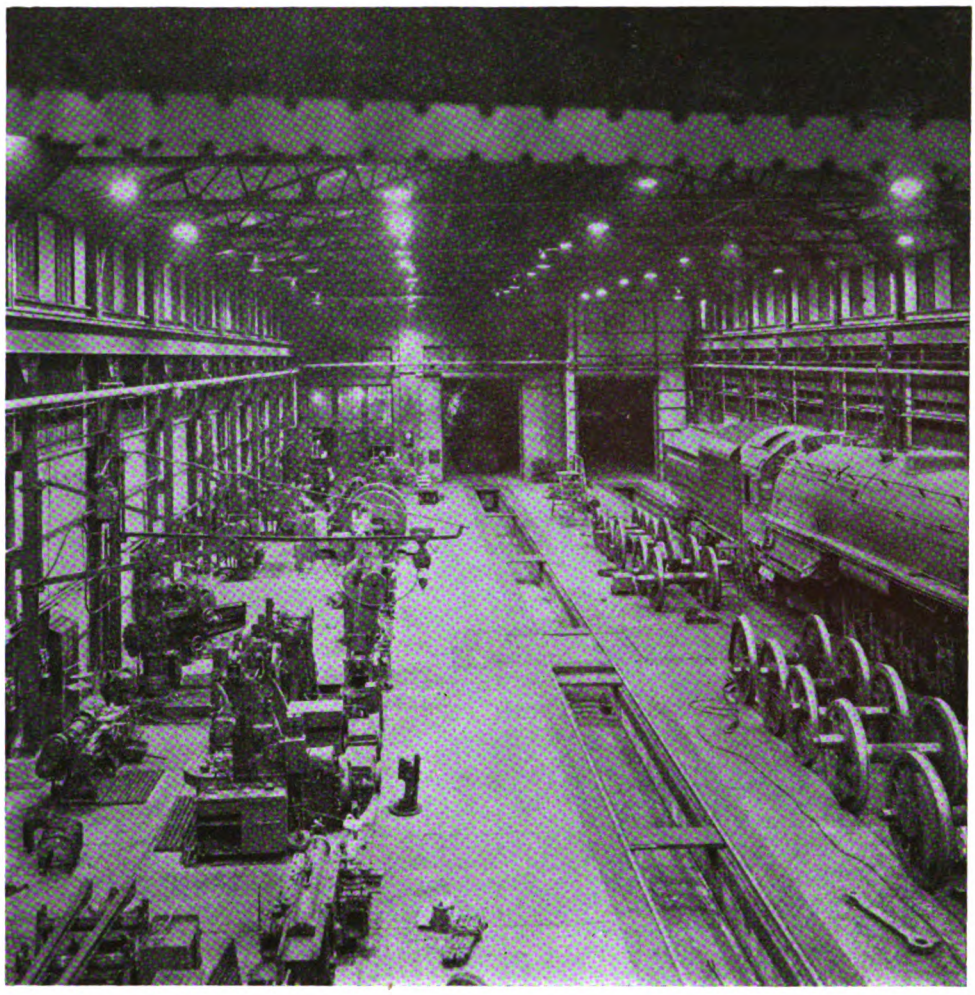
The foundation of the modern freight-car truck is, of course, the cast-steel bolster, and side frame with integral journal boxes, which represent years of experience and development largely on the part of the manufacturers who now furnish both side frames and bolster castings of adequate strength, reliability and wear resistance, and entailing only a small fraction of the expense required in maintaining earlier designs. Comparatively recent improvements in truck design have included elimination of the more or less troublesome spring plank and the provision of enough flexibility between bolsters and side frames so that trucks can negotiate curves more easily at high speeds, with less thrust and wear on the wheel flanges, truck frames, journal boxes and associated parts. Like other truck parts, lightweight brake beams are now available, made of high-tensile steel and meeting all A. A. R. strength requirements. The necessity of providing reliable brake-beam suspension, and safety hangers to support the brake rigging in the event that any part fails needs hardly be stressed, in view of potential hazards, particularly in high-speed operation.

Modern draft gears, hand brakes, door-operating mechanism and other important details are destined to play their part in the freight car of the future. In box cars, the metal roofs must not only serve as part of the car structure to tie the sides and ends together, but be waterproof and treated on the inside to overcome condensation difficulties. A number of railroads have experimented with various insulating compounds sprayed on the interior roof sheets, and others have applied complete inside roof linings of plywood, or other materials, in attempts to prevent condensation losses. In refrigerator cars, insulation materials and their application constitute a major problem.

The manufacturers of all these various materials and devices have worked with the car builders and the railroads, in developing designs of freight cars which are efficient, revenue-earning units vastly superior to earlier types. In view of potential operating economies, improved service, reduced damage claims and lessened maintenance expense, the sooner the present large inventory of obsolete, worn-out freight cars is replaced by new and modern equipment the better it will be for the railroads.

* * *





Factors Which Influence

The Cost of Maintenance

Modern locomotive design and improved repair facilities and methods have enabled the roads to stabilize the unit cost of maintenance while motive-power capacity increases

IN THE process of accumulating the information from which to prepare this article the writer called upon a mechanical officer who is well known for the soundness of his views on policies affecting locomotive repairs and asked him these questions: "What have been the most important factors in locomotive design which have contributed to a reduction in the cost of locomotive repairs?" and "What changes in shop facilities or methods have contributed to a reduction in the cost of locomotive repairs?" His answer to these questions came immediately in the form of another question: "Upon what do you base the assumption that there *has* been a reduction in the cost of locomotive repairs?" The ensuing discussion merely served to emphasize again the fact that in matters relating to railroad operation it is not always safe to assume that a condition relating to the country as a whole is equally a fact when applied to one particular road and, conversely that which may be true concerning operation on one road does not always apply to the country as a whole.

The assumption upon which the statement was made was based upon the fact that the cost of repairs per locomotive mile in freight service dropped 25 per cent during the period from 1924 to 1936 (the latest year for which complete figures are available) for the Class I roads. It would seem that one might assume that the cost of locomotive repairs has undergone a similar reduction on all well-operated roads, whereas it will be found that on some roads this figure has remained about the same or has resulted in a slight increase. It is of incidental interest to note that the cost of locomotive repairs per locomotive mile in freight service has increased 13 per cent since 1932, the year in which the "per-mile" figure was the lowest.

There is a difference of opinion among mechanical men as to the value of the per-mile figure, its opponents contending that it is not a true indicator because of the fact that it ignores the size of the locomotive with the

attendant increase in the hauling capacity. It is entirely outside the scope of this article to discuss the value of the figure except as an indicator of a trend. As such it indicates that the unit cost of locomotive repairs in freight service has been consistently reduced over a period of years to the low point of 1932 with the single exception of 1923 in which the effects of deferred maintenance during the shop men's strike were being paid for. Since 1932 the unit cost has been consistently increased until now it stands at 13 per cent above 1932 and 25 per cent below 1924.

During the 8 years from 1924 to 1932 the expenditures for freight locomotive repairs declined from 321 to 128 million dollars, increasing by 1936 to 193 million dollars. (Freight locomotive repair cost has remained consistently at an average of 70 per cent of all steam locomotive repairs.) During the same period freight locomotive mileage dropped from 998 to 607 million and up again to 804 million by 1936. Gross ton-miles, on the other hand, increased from 954 to 1,141 million from 1924 to 1929; decreased to 657 million in 1932 and came back to 896 million in 1936. Train loading increased from 1,588 gross tons in 1924 to 1,870 in 1930 (1929 was 1,866); decreased to 1,682 in 1932 and rose again to 1,860 in 1936. The average train load of 1,902 gross tons in 1937 is the highest during the entire period.

These statistics might serve only to confuse the discussion were they not valuable in providing the background for the statement that, taking the Class I roads as a whole, the cost of locomotive repairs in freight service has decreased substantially on the locomotive-mile basis while the transportation tool for which the money has been spent is doing a bigger job today than it has ever done before.

It is undoubtedly true that over the entire period there has been a substantial improvement which has been reflected in the unit cost figure but it is equally true, especially since 1929, that a considerable part of the reduction in unit cost has been the result of deferred maintenance. Then too, over that same period the unit cost basis has had the advantage of a condition in the railroad industry in which the gradually diminishing volume of demand for motive power has made it possible to utilize locomotive mileage which never had to be restored. Were statistics available to develop such a unit the "cost of locomotive repairs per mile restored" might result in an entirely different picture.

An analysis of general statistics falls far short of developing data to prove what is known to be a fact; namely, that the average locomotive of today will run from three to four times as many miles between shoppings for general repairs as the locomotive of 1924 would and does haul about 25 per cent more tonnage per train at a higher speed than did its predecessor of 14 years ago. That, in simple terms, is a statement of the job it has done, and the fact that it has accomplished such a job at a unit repair cost no greater than, and probably less than, the cost of 1924 is sufficient justification for its continued existence.

How has this job been accomplished? The answer lies in two important factors: (1) Improvement in design and in operation, and (2) improvement in the character of facilities and the methods used in locomotive repair work.

The Influence of Design

One of the distinct advantages of the locomotive of today is its ability to stay away from the repair shop for much longer periods than its predecessor of 10 to 15 years ago. Many changes in design have taken place which have contributed materially to a situation wherein locomotives may have performed assigned mileages ranging from 100,000 to 200,000 miles of road service between shoppings instead of from 30,000 to 75,000 miles. The advantages of many of the materials and devices such as alloy-steel rods, axles and motion parts, cast-steel beds and roller bearings, are too well known to warrant detailed repetition here. In boilers and fireboxes, alloy-steel sheets, and welding have played an important part while water treatment alone has gradually extended the required time for flue renewals. In addition the introduction of force-feed oil lubrication and pressure grease lubrication has served to reduce wear on parts to such an extent that, in one case, a locomotive stayed out of the general repair shop for four years.

Improvements in Repair Facilities and Methods

Of outstanding importance in maintenance work during the past 15 years have been two major changes: The development of preventative maintenance on locomotives, and the gradual concentration of repair work at shops and terminals where the facilities are the most modern. The idea of repairing locomotives for a predetermined term of service came in with the introduction of longer locomotive runs. Operating conditions demanded the latter in the interest of economy and it was found that a much higher standard of maintenance was required in order to assure reliable service over longer distances. Because locomotives are required to be inspected regularly, advantage is taken of washout periods to perform such minor repair work as will keep motive power in service without interruption. This results in the ability to perform greater service without attendant and proportionate increases in repair costs.

When it is considered that the modern locomotive—whether it be new power or modernized power—is a much more complicated machine than one of several years ago it is really remarkable that it can be maintained within the cost figures that are being established today. Obviously the cost of a general-repair job on modern power is greater than it used to be but the greater service rendered holds down the cost per unit of service rendered.

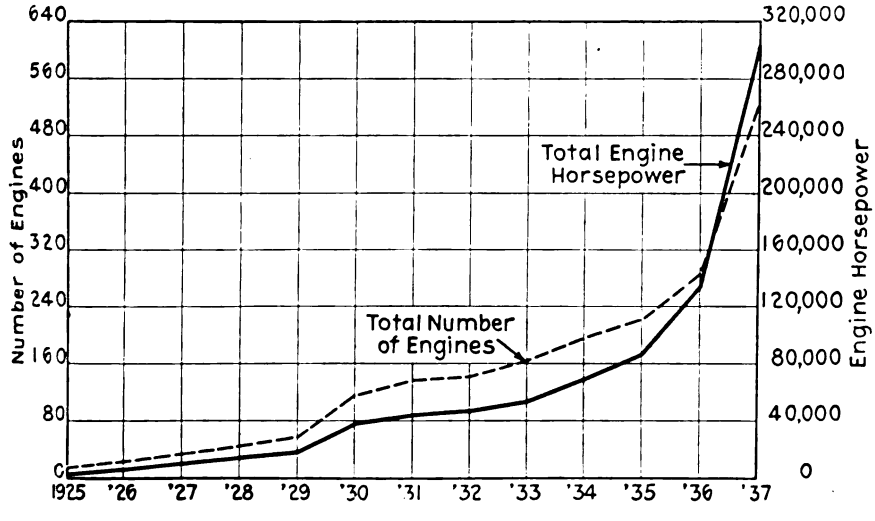
No small part of the ability to do this has been due to radical changes in the methods of shop operation as well as in the tools with which the job is done. The changes that have taken place in the system of shop functioning as well as the idea which has prompted the replacement of many obsolete units in the shops have been made to assure production in volume at low unit cost. Unfortunately, business conditions have not provided a sufficient volume of repair work to enable the roads to determine what may be the maximum savings effected as a result of expenditures for new facilities, but the actual savings in numerous cases have been enough to indicate the course to be pursued in the future.

Several facts stand out very clearly. We should not be deceived by what may appear to be a satisfactory reduction in the unit cost of maintenance. It is perfectly obvious that much of this reduction since 1929 has been the result of deferred maintenance. The restoration of a balance in locomotive mileage after a period of curtailed expenditures is usually done at an increase in unit cost and there is always the danger, in our zeal to effect economies, of being in the embarrassing position of the man who burned his furniture to heat the house. He may run out of furniture before the winter is over. The margin between revenues and expenses is narrowing all the time and with this condition the absolute necessity of reducing expenses to stave off bankruptcy is becoming more acute. It appears that the day is here when railroad men can no longer ignore the possibilities of modern power and locomotive repair facilities as a means of effecting such a reduction.

Diesel-Electric Locomotives in the United States and Canada

Railroad	No. of units	Service	Name of builder of Locomotive	Engine	Elec. equip.	Engines No.	hp. each	Total weight, lb.	Date in service
A. T. & S. F.	2	Switch.	Alco	Alco	West.	1	600	200,000	1937
	1	Pass.	E. M. C.	Gen. Motors	Gen. Elec.	4	900	500,000	1937
	1	Switch.	Baldwin	Baldwin	Allis-Chalmers	1	600	200,000	1937
	3	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
	3	Switch.	E. M. C.	Gen. Motors	West.	1	900	250,000	1937
	2	Pass.	E. M. C.	Gen. Motors	Gen. Elec.	4	900	500,000	1938
	6	Pass.	E. M. C.	Gen. Motors	Gen. Elec.	2	900	250,000	1938
B. & O.	4	Pass.	E. M. C.	Gen. Motors	West.	4	900	500,000	1937
	1	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
B. & L. E.	1	Switch.	Baldwin	West.	West.	2	265	140,000	1936
Birmingham Southern	6	Switch.	Alco	Alco	West.	1	900	230,000	1937
	5	Switch.	E. M. C.	Gen. Motors	West.	1	900	250,000	1937
Boston & Maine	1	Switch.	Alco	Alco	Gen. Elec.	1	600	200,000	1938
(Portland Terminal	1	Switch.	Alco	Alco	Gen. Elec.	1	600	200,000	1938
Canadian Pacific	1	Switch.	Nat'l Steel Car	Harland & Wolff	Laurence Scott Co.	1	600	200,000	1937
Canton R. R.	1	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
Chicago & Eastern Illinois	1	Switch.	Alco	Alco	Gen. Elec.	1	600	200,000	1938
	2	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1938
Chicago & Illinois Western	1	Switch.	Alco	Alco	West.	1	600	200,000	1935
Chicago, Burlington & Quincy	6	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
	2	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	900	250,000	1937
Chicago, Rock Island & Pacific	6	Pass.	E. M. C.	Gen. Motors	Gen. Elec.	1	1,200	210,000	1937
	18	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937-8
	2	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	900	250,000	1938
East Erie Commercial	1	Switch.	Gen. Elec.	Cooper-Bessemer	Gen. Elec.	1	300	114,000	1935
	1	Switch.	Gen. Elec.	Cooper-Bessemer	Gen. Elec.	1	300	114,000	1937
	1	Switch.	Gen. Elec.	Waukesha	Gen. Elec.	2	165	112,000	1935
E. J. & E.	9	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
	2	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	900	250,000	1937
	1	Switch.	Alco	Alco	Gen. Elec.	1	900	230,000	1937
	1	Switch.	Alco	Alco	West.	1	600	200,000	1937
Ft. W. & D. C.	1	Switch.	Cummins	Cummins	Gen. Elec.	2	500	180,000	1936
Great Northern	1	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	900	250,000	1937
	1	Switch.	E. M. C.	Gen. Motors	West.	1	900	250,000	1937
Lehigh Valley	2	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
	4	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	900	250,000	1937
Massena Term. Ry.	1	Switch.	Alco	Alco	Gen. Elec.	1	600	200,000	1937
Missouri Pacific	4	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
	2	Switch.	E. M. C.	Gen. Motors	West.	1	900	250,000	1937
Monongahela Connecting	1	Switch.	Gen. Elec.	Cooper-Bessemer	Gen. Elec.	2	300	164,000	1936
	1	Switch.	Gen. Elec.	Cooper-Bessemer	Gen. Elec.	2	500	240,000	1937
	2	Switch.	Gen. Elec.	Cooper-Bessemer	Gen. Elec.	2	300	160,000	1937
New Orleans Public Belt	3	Switch.	Baldwin	Baldwin	West.	1	900	240,000	1937
N. Y. N. H. & H.	10	Switch.	Alco	Alco	Gen. Elec.	1	600	200,000	1938
Northampton & Bath	1	Switch.	Bethlehem	West.	West.	2	800	266,000	1937
Patapsco & Back Rivers	5	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
	5	Switch.	Alco	Alco	Gen. Elec.	1	600	200,000	1937
	2	Switch.	Alco	Alco	West.	1	600	200,000	1937
Pennsylvania	1	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
Peoria Terminal	1	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
Phila., Beth. & N. E.	4	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
	4	Switch.	E. M. C.	Gen. Motors	West.	1	900	250,000	1937
Reading	6	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1937
	2	Switch.	Alco	Alco	Gen. Elec.	1	900	230,000	1937
River Terminal	2	Switch.	E. M. C.	Gen. Motors	Gen. Elec.	1	600	200,000	1936
South Buffalo Ry.	1	Switch.	Alco	Alco	Gen. Elec.	1	900	212,000	1937
	8	Switch.	Alco	Alco	Gen. Elec.	1	600	200,000	1937
Union Pacific	1	Pass.	Pull.-Std.	Gen. Motors	Gen. Elec.	1	1,200	200,000	1936
	1	Pass.	E. M. C.	Gen. Motors	West.	6	900	1,020,000	1937
	1	Pass.	E. M. C.	Gen. Motors	Gen. Elec.	6	900	1,020,000	1937
	1	Pass.	E. M. C.	Gen. Motors	Gen. Elec.	4	900	.....	1937
Warrior River Term.	1	Switch.	Alco	Alco	West.	1	900	230,000	1938
Youngstown Northern	2	Switch.	Alco	Alco	Gen. Elec.	1	900	230,000	1937
	2	Switch.	E. M. C.	Gen. Motors	West.	1	900	250,000	1937

* This list supplements one published in the February, 1937, *Railway Mechanical Engineer* and includes units placed in service or ordered between January 1, 1937, and March 1, 1938.



The chart to the left shows the total number of Diesel engines and the total Diesel engine horsepower installed in motive power units (locomotives and rail cars) in the United States and Canada. The 1937 total includes units placed in service up to March 1, 1938. Of special interest is the fact that the total horsepower installed in the 14 months from January 1, 1937, exceeds the total for the previous 12 years

Gleanings *from the* Editor's Mail

(The Apprentices Speak)

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Special Problems for "Specials"

Many special apprentices have stated that they wished they had some responsible problem to work on just to keep in shape with their past college work. The railroads that hire these special apprentices could help themselves and the special apprentice by giving him some problem to analyze and work on, which the railroad or the shop is working on, together with his regular training course. This will let him feel that he is doing something for his company and at the same time build up his confidence, which the railroads do need in their men.

Work Hard at the Job

Truly, it is easy to look on the dark side these days of "recession." If a fellow is going to get ahead he must work—by this I mean, study and get all the outside information of his trade he can obtain. Before a young man learns the machinist trade he should have his mind made up as to whether or not he will like this trade for his life's work. I am taking a correspondence course and feel that every apprentice should. Last, but not least, I think an apprentice should take magazines such as the *Railway Mechanical Engineer*. It has proved very helpful to me and I think very highly of it. I think the railroads should encourage this outside help more than they do.

Written Instructions in the Shop

During the time spent by a special apprentice in various shops much effort is made to secure written instructions on the work, and it has been found that in the majority of cases these instructions are scarce and cannot be taken out. These instructions should be given to each and every apprentice and special apprentice upon entrance to each shop, and be returned to the shop when he leaves, so that he may study while working on the equipment. The foreman and high officials should meet at their convenience periodically to question and be questioned by these apprentices. The better the relations established between the men in training and the railroads, the stronger the bond will be in securing a reliable and substantial foundation for the future.

Technically Trained Men Needed

A group of technical men having special training and ability to co-ordinate the efforts of the mechanical, operating and maintenance departments could be inestimably valuable. Unfortunately for the well-being of the railroads, it is impossible for some men to see from their own rut the problems facing other departments. These specially trained men would be better equipped to analyze possible economies as a whole, rather than with the viewpoint of but one department. While I fully recognize the inexperience of the technical graduate, his suggestions are usually worthy at least of examination, because he has not only been trained to examine facts thoroughly, but has the advantage of the newcomer's perception Such men could be very well developed into executive material.

A Special Apprentice Comments

What is needed most is a carefully worked out plan of instruction for apprentices and a person of experience and foresight to have direct supervision over them, and to see that they are given a varied training and not left in one department for the duration of their course of training. As it is now, the majority of apprentices are left to shift for themselves in shops or enginehouses, or else they are assigned to special duty and never get a chance at other work. Consequently, when positions are open the lack of experience generally prevents the apprentice from filling these vacancies.

Apprentices Need Training in Theory

Concerning apprenticeship training, I think that the railroads should hold classroom periods two days a week for one hour each, to give the apprentice the theoretical as well as the practical background. One reason I am a subscriber to the *Railway Mechanical Engineer* is because I desire the theories found within this fine publication. I have studied from various books and pamphlets, seeking further knowledge. The past three years I have been and still am attending night school. I have studied courses in heating, ventilation and air conditioning; production methods and tool engineering, and machine design. These have all been very helpful to me.

Square Pegs in Round Holes

The boy (apprentice), more often than not, regards his apprenticeship as merely a job until he can get something better. No attempt is made to fit him to a job, or to improve his ability. Potential boilermakers may be found in any brass shop, and good welders may be going to waste in the machine shop. Usually they are placed where they are needed today, without regard for where they will be needed tomorrow. A great deal more can be said on both sides, but today, the only way to morally justify the low rates paid to apprentice boys is to give them training that will be valuable even though they can expect nothing more than an indefinite lay-off when their period of training is over. I believe the fundamental solution lies in the development of personnel departments with ability and authority to co-ordinate apprentice programs with the needs of the railroad, and to create better personnel relations within the industry.

Railroads Should Protect Apprentices

If the railroads don't train apprentices and then when they are in need of mechanics they get men trained on the outside, they are decreasing efficiency and increasing their maintenance bill. How? Because the outside man is coming into a strange plant and doesn't understand the work like the man that has been trained in the railroad shops. Therefore, when times like the present arrive and the railroad operates a skeleton crew, there should be a rather large group of apprentices working, in order that they may finish their time. If an apprentice must serve four years, but it takes him eight, due to shut-downs, then he becomes discouraged, loses interest in his work and finally leaves. My first interest is the railroad and I think it is my future and that I can accomplish something on a railroad; but when I have been furloughed for seven months without any sign of going back in the near future, I just can't help but stop, look and listen for a moment.

THE READER'S PAGE

Smokeless Operation of Steam Locomotives

To the Editor:

The problem of securing the proper combustion of coal, thereby diminishing the smoke nuisance and other well-known troubles, has confronted the operators of locomotive engines since the earliest days of railroading. There is still extant a manuscript containing a legal opinion dated August 9, 1814, relating to the locomotives then in use on the Wylam Colliery Railway in England. This opinion asserts that "in the operation a little noise and Smoak is certainly made which A considers a nuisance." How often since that day has this same complaint been echoed!

In the April number of the *Railway Mechanical Engineer,* there is an abstract of a report by William G. Christy, in which he intimates that modern American locomotives suffer from poor combustion, or incomplete combustion. Mr. Christy advocates the introduction of air over the fire in some manner, and suggests that it may be necessary to redesign the firebox in order to attain this end. The admission of a secondary supply of air above the fuel-bed is unquestionably sound in principle, and the practical application of the idea has received a great amount of attention on American railroads. Failure to evolve any generally accepted standard practice may be charged very largely to the fact that the expense and difficulty of maintaining the most efficient arrangements, which were too often the most complicated ones, were generally more than sufficient to balance any gain from improved combustion.

In the days of hand-firing, firemen were frequently given detailed instructions for minimizing the emission of smoke by proper manipulation of the firedoor. This practice can be a source of trouble, because of incomplete mixture of the incoming air with the firebox gases sometimes resulting in quantities of comparatively cold air striking the tube-sheet with anything but a beneficial effect. Combustion tubes similar to those described in the *Railway Mechanical Engineer* for February, 1936, page 48, have been applied in large numbers on various railroads, ever since D. K. Clark perfected this ancient system of induced air jets in 1858. Several Class I railroads have used them on most of their larger engines for many years. The experience of these railroads should indicate the value of such an appliance. It seems only reasonable to conclude that the tubes would have been abandoned long ago if they had not served their purpose.

The well-known Gaines firebox and combustion chamber, with its brick wall containing passages through which heated air is admitted above the fire, should be familiar to most readers. This was perhaps the most successful of all the more ambitious attempts to secure a continuous influx of fresh air over the fuel-bed. Its use was widespread, but recent applications have been mostly confined to large articulated locomotives. The feeling of many American engineers toward such devices as this was once expressed by an eminent authority in the following words: "It is doubtful whether the question of the value of various forms of the brick arch for admitting hot air, etc., will ever be satisfactorily settled in any one way to the community at large."

In contrast to the apparent lack of agreement among American engineers regarding those adjuncts of the locomotive firebox which tend to promote smokeless combustion, little divergence of opinion exists in Great Britain. There, the question of burning bituminous coal with a minimum of smoke was definitely settled by the work of Charles Markham on the Midland Railway between 1856 and 1860. Air-tubes through the firebox front and sides, solid and perforated brick arches, combustion chambers of varying degrees of complexity, etc., were all tried and discarded. (It is only in very recent years that the combustion chamber has reappeared in the boilers of 4-6-2 and 2-8-2 type engines, as a means of keeping the tubes to a moderate length.) The solution finally arrived at embodied a long, solid brick arch, and provided for the continuous admission of a supplementary air supply through the firedoor. A deflector plate was attached to the inside of the fire-hole to direct this air downward toward the surface of the fuel-bed.

In Germany, the evolution of smoke-consuming apparatus began very early and covered a long period. Simple and complicated devices of almost every imaginable variety were tried, culminating in the present standard Marcotty firedoor, which has now been reduced to a very simple form, the steam jets and automatic blower formerly incorporated having been abandoned as costly and unnecessary refinements. With the Marcotty arrangement, air is automatically drawn in through specially designed passages beside the firedoor and discharged above the fire, whenever the firebox vacuum exceeds a predetermined figure. It may be worthy of investigation by those who aim to improve the process of combustion in American locomotive fireboxes.

W. T. H.

A Suggestion to Eliminate Piston-Rod Failures

To the Editor:

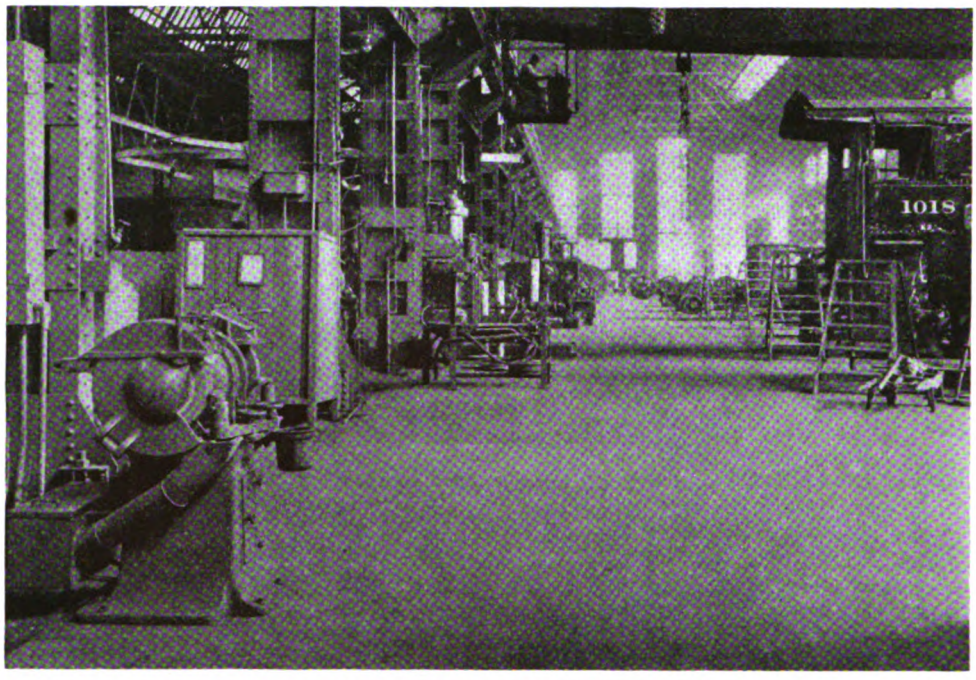
The locomotive accident reports give over a thousand piston-rod and crosshead failures per year. Most of those failures may have been caused by a lack of exactness in the most essential detailing of taper end of piston rod key and slot.

Piston-rod failures may be divided into two main classes: (1) Failure at the small end of the taper fit, and (2) failure at the large end of the taper fit. Most failures at the small end start the first day the key is driven into place. The key, lacking substantial supporting metal, simply will not stay put and the only recourse is the use of the hammer. The severe wedging action of the key and reverse stresses start cracks and promote early failure.

Nearly all failures at the large end of the taper seat may be caused by eccentric loading. The crosshead-pin vibrations may concentrate at this point because the cross-sectional area of the piston rod is less than the body. It is believed by engineers that were the taper seat increased in diameter by 25 per cent all stresses and high vibrations might be transferred to the body of the piston rod and there harmlessly eliminated.

Frank Rattek.

IN THE BACK SHOP AND ENGINEHOUSE



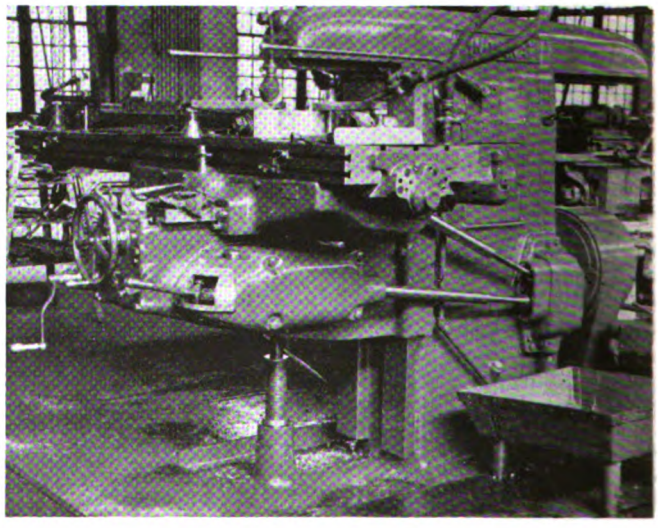
The Danville locomotive erecting shop has been improved by a new concrete floor

Locomotive Shop Improvements at Danville

During the past two years the Chicago & Eastern Illinois has made a number of improvements at its main locomotive repair shop, Danville, Ill., which are expected to have important effects in improving the quality and reducing the cost of locomotive maintenance work on this railroad. Included in the improvement program has been the installation of 10 modern machine tools, 10 electric floor grinders, 7 new electric drives to existing machines, 1 electric-driven pipe bender and 5 Ingersoll-Rand pneumatic hoists. This new equipment, installed at a cost of approximately $125,000, replaces at least 40 antiquated, worn-out shop tools which were scrapped. In addition, a pair of Whiting 25-ton car hoists has been purchased and temporarily installed in the boiler shop where several tracks are assigned to car work pending the building of a new coach shop to replace the one destroyed by fire several months ago. An important improvement in the erecting shop has been the installation of a new concrete floor.

The Danville locomotive machine shop is a brick structure 620 ft. long by 150 ft. wide, equipped with 28 locomotive repair pits, spaced 22 ft. apart on centers in the south half of the building which faces the transfer table. The machinery bay in the north half of the locomotive shop is provided with the necessary equipment for the expeditious handling of the many machine operations required in machining and repairing locomotive parts. Locomotives are unwheeled and wheeled by means of a 100-ton crane in the erecting shop which leaves the transfer table, with which the shop was originally equipped, free for the almost exclusive handling of passenger equipment to the coach shop and storage tracks south of the table. A second crane in the erecting shop, of 15-ton capacity operates under the 100-ton crane and is used for the handling of heavy locomotive parts.

One of the first improvements made at the Danville shops was the application of a new concrete floor in the erecting shop to replace the wood floor formerly used. Approximately 43,000 sq. ft. of concrete was laid 12 in. deep, the entire length of the erecting shop. While representing quite a substantial outlay, the advantages gained were decidedly worth while and will be realized for many years to come. Truck operations and the movement of material, for example, are greatly facilitated; floor maintenance is eliminated which saves at least $900 a year, formerly spent renewing the planking; locomotive maintenance work is no longer interrupted while making floor repairs; it is easier to keep the floor clean and accident possibilities are reduced.



Cincinnati No. 5 plain miller set up for machining a side rod on the 66-in. table

In the machine department practically all machine tools have been re-arranged and placed for the more effective handling of the work. Monorail hoists and jib cranes are installed, as shown in the illustration, to facilitate material handling to the various machine tools. For example, one monorail hoist equipped with a 2-ton Ingersoll-Rand machine serves six tools, including a radial drill, a 50-ton hydraulic press, two draw-cut shapers, one boring mill and one slab miller. This serves all machines in the driving box gang. Jib cranes are installed to serve all heavy machine tools as needed. Four 1-ton Ingersoll-Rand hoists replace cylinder air hoists, providing faster and safer handling of heavy material.

New Machine Installations

Some of the most important of the new machine tools installed at Danville shops are listed in Table I. They replaced the following machines which were scrapped; 7 planers, 2 shapers, 9 engine lathes, 3 turret lathes, 4 boring mills, 4 drill presses, 1 pipe bender and 10 grinders.

Almost no change was made in the wheel department except for the rearrangement of existing machine equipment to provide for more orderly handling of the work. Most of the new tools were installed for the use of gangs specializing on the following work: driving boxes, rods, pistons and crossheads, valve gears, etc. The Ingersoll milling machine and the Bullard 42-in. vertical turret lathe went to the driving box gang; the Bullard 24-in. machine and the Micro grinder to the rod job; the American heavy-duty engine lathe and radial drill to the piston and crosshead job; the No. 5 Cincinnati miller to the valve job; the Pratt & Whitney lathe to the tool room; the Jones & Lamson turret lathe to the general machine department; and the 10 floor grinders were installed wherever they could be used to the best advantage throughout the shop.

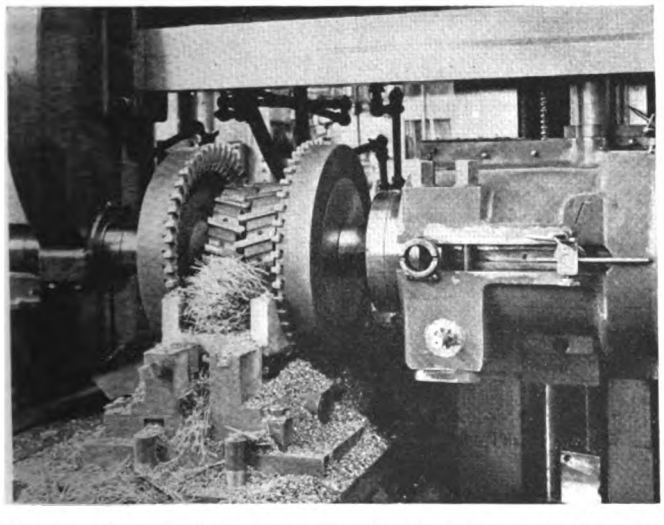
The first tool shown in the list of new machine installations is the Ingersoll slab miller which is used for machining driving boxes, shoes and wedges, crosshead shoes, engine truck and trailer boxes, guides, etc., both new and repair work. It is estimated that the machine saves at least 35 per cent in time and labor cost over previous methods of machining these parts on planers. For example, 24-in. brass shoes and wedges were formerly machined from rough castings at the rate of 14 hr. per set of 16, using two settings on a planer. These shoes and wedges are now machined two at a time while held in a special jig on the Ingersoll machine, finishing five surfaces simultaneously at the rate of six shoes and wedges an hour, or roughly 3 hr. for the 16 shoes and wedges. A cutting feed of 4½ in. per min. is used and, after the original allowance of one hour for setting up the jig in the machine, about 5 min. is required for adjusting and clamping each pair of shoes and wedges.

Like all new machines installed at Danville shops, the Ingersoll miller is fully equipped with necessary special fixtures and cutting tools, without which the investment in the machine itself can never bring satisfactory returns. In this case, the fixtures include one driving box fixture, one shoe-and-wedge fixture, one cross-head fixture, one arbor support, both serrated and inserted blade cutters, arbor mills, nut shanks and a solid shank 3½-in. boring bar. The larger fixtures and tools are kept safe off the floor on a steel rack of ingenious design, conveniently located with respect to the miller. Small tools and milling cutters are kept in a special steel locker with wood-lined shelves. The objective, of course, is to keep all special tools used with this machine in good condition and have them conveniently available where and when needed.

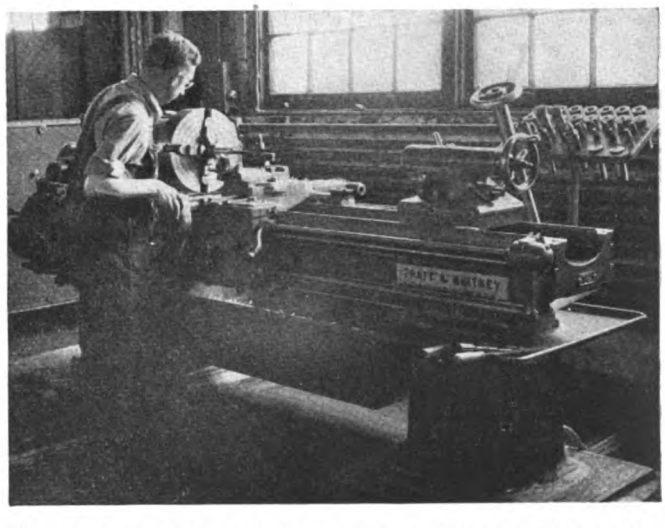
Table I—New Machines Installed at Danville Shops

87—Bullard 42-in. spiral-drive vertical turret lathe
89—Jones & Lamson 3½-in. turret lathe
90—American 6-ft. radial drilling machine
91—Bullard 24-in. spiral-drive vertical turret lathe
100—Toledo No. 999 pipe threading machine
101—Wallace No. 424 pipe-bending machine
102—Micro railroad-model internal grinding machine
103—Cincinnati No. 5 plain high-power milling machine
104—American 27-in. by 96-in. heavy-duty engine lathe
105—Ingersoll 36-in. by 36-in. by 12-ft. railroad-type 3-head milling machine
106—Pratt & Whitney 16-in. by 66-in. toolroom lathe
...—U. S. motor-driven ball-bearing floor grinders (10)
...—Ingersoll-Rand pneumatic hoists (5)
...—Whiting 250-ton portable car hoist (2)
Cullman individual electric motor drives applied to:
24-in. engine lathe, No. 2
24-in. shaper, No. 83
20-in. engine lathe
18-in. nut facer, No. 18
Milling machine, No. 44
16-in. engine lathe, No. 43
20-in. engine lathe, No. 39

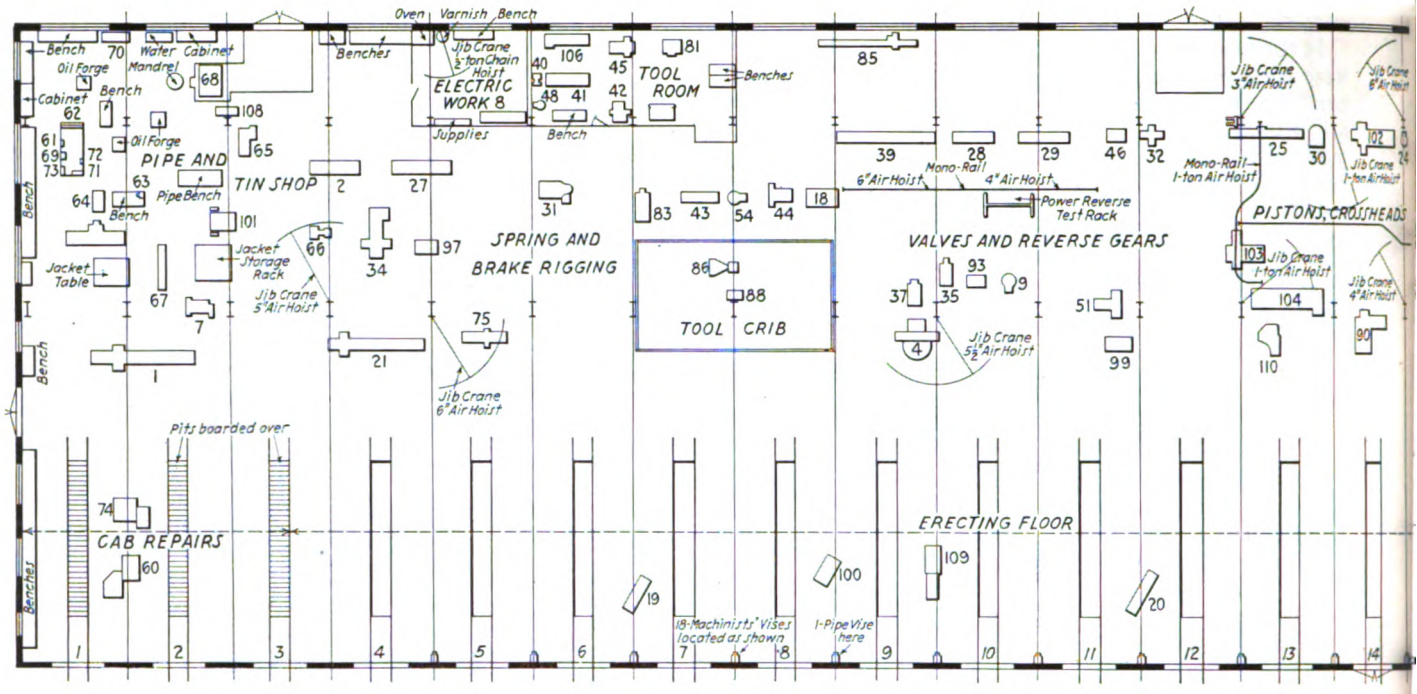
The Bullard 42-in. spiral-drive vertical turret lathe is used for machining large crown brasses, piston heads, valve bushings and similar work, also for boring cross heads for the piston and wrist-pin fits. In the latter work, accurate taper and smooth finish are absolutely essential in order to minimize the subsequent hand lapping operation. A special driving box chuck is used when boring



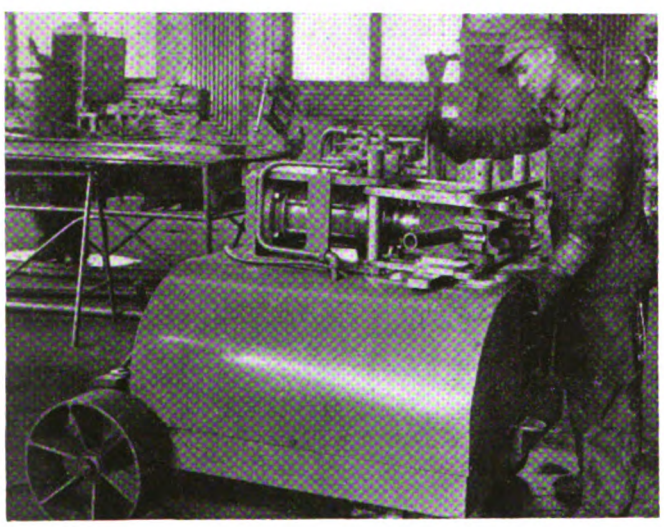
Close-up view of milling cutters finishing five surfaces simultaneously — The chip formation tells its own story



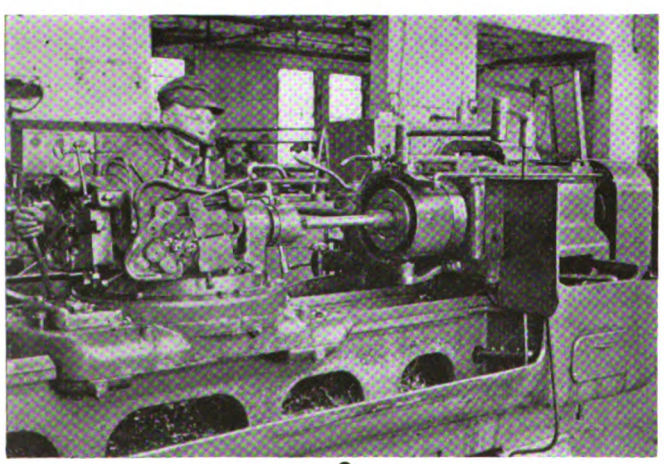
This new 16-in. engine lathe is used for a variety of toolroom work—Note the convenient collet rack



Layout of machine tools and shop facilities in



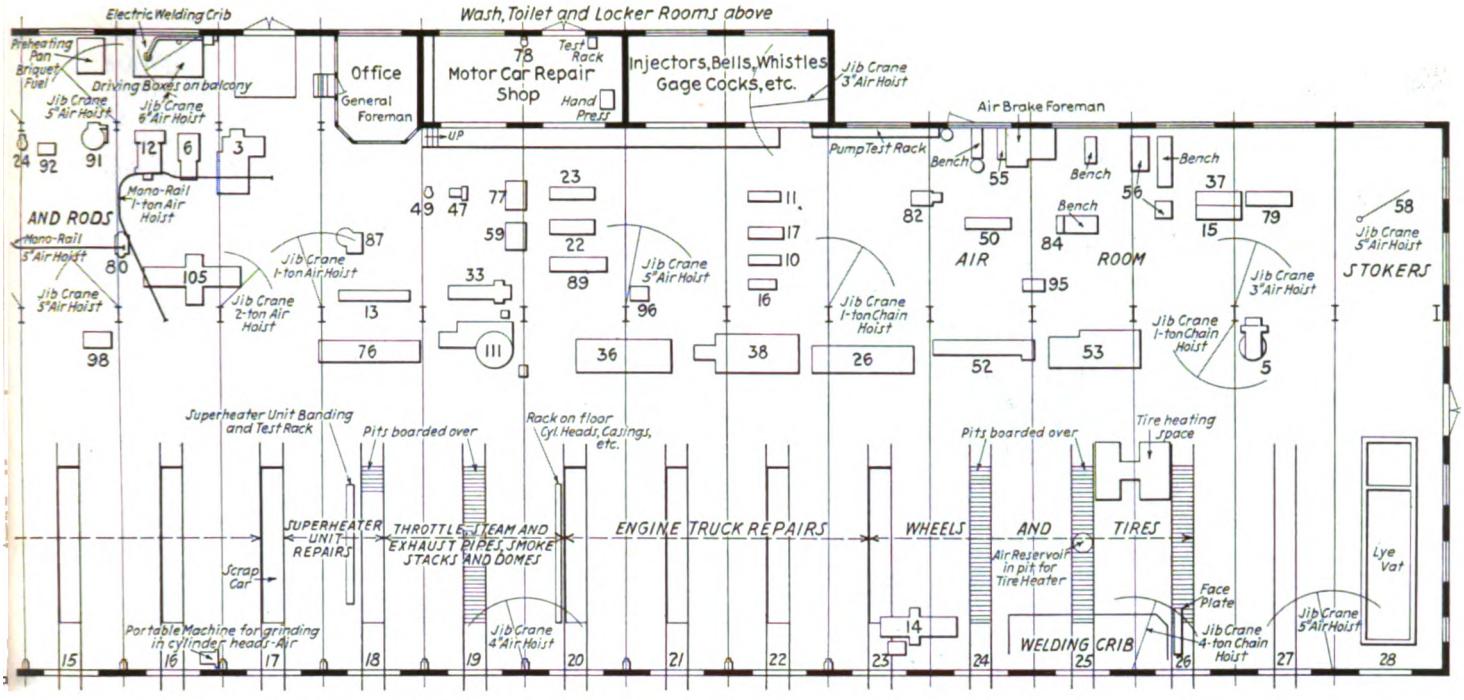
Wallace portable hydraulic pipe-bending machine which bends cold all sizes up to 4 in.



Jones & Lamson 3½-in. turret lathe as set up for the production of engine bolts from bar stock

Machine Tool and Equipment Units in the Danville Shops

Machine No.		Location, Pit No.
1	48-in. planer	1
2	24-in. lathe	3
3	72-in. radial drill	17
4	51-in. boring mill	9
5	18-in. slotter	27
6	32-in. draw-cut shaper	16
7	Liner press	2
8	16-in. lathe	5
9	Sensitive drill	10
10	16-in. lathe*	22
11	24-in. lathe*	22
12	26-in. draw-cut shaper	16
13	22-in. engine lathe	18
14	30-in. horizontal miller	23
15	3T triple test rack	27
16	14-in. lathe*	22
17	18-in. lathe*	22
18	Nut facer	8
19	16-in. portable bolt lathe	6
20	18-in. portable bolt lathe	11
21	36-in. planer	4
22	2-in. by 30-in. turret lathe	20
23	2-in. by 30-in. lathe*	20
24	Sensitive drill	14
25	30-in. gap grinder†	13
26	42-in. axle lathe	23
27	27-in. lathe	4
28	18-in. lathe	10
29	18-in. lathe	11
30	50-in. upright drill	13
31	48-in. upright drill	6
32	50-ton hydraulic press	12
33	30-in. planer	19
34	24-in. guide grinder*	4
35	26-in. shaper*	10
36	85-in. quartering machine*	20
37	18-in. lathe	9
38	90-in. wheel lathe	22
39	24-in. lathe	9
40	Sensitive drill	6
41	16-in. lathe	6
42	Universal grinder	6
43	16-in. lathe	7
44	Universal miller	8
45	Toolroom miller	6
46	Disc grinder	11
47	Milling machine*	19
48	24-in. upright drill*	6
49	Sensitive drill	19
50	18-in. lathe*	24
51	Milling machine*	11
52	600-ton, 90-in. hydraulic press	24
53	84-in. wheel lathe	25
54	10-in. slotter*	8
55	Gage and safety-valve tester	24
56	Test racks	26
57	3T triple test rack	26
58	Jib crane	27
59	2-in.-3-in. bolt threader*	19
60	42-in. band saw	1
61	Folder	1
62	42-in. rolls	1
63	Shear	2
64	36-in. shear	1
65	6-in. pipe threader	3
66	Sensitive drill	3



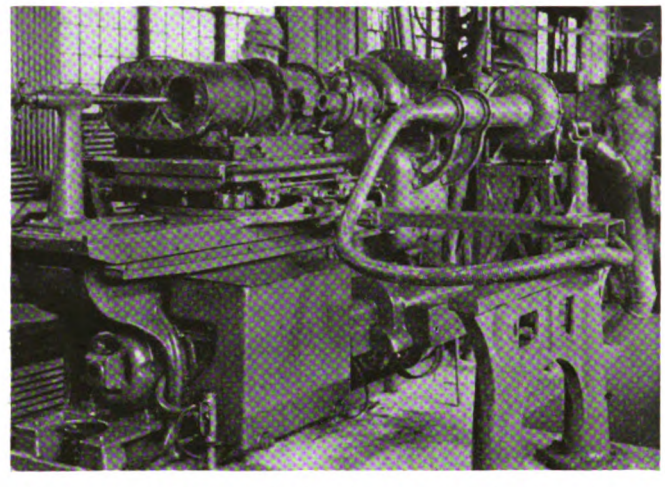
the Danville locomotive shops of the C. & E. I.

Machine No.		Location, Pit No.
67	8-ft. Cornish hand brake	2
68	Babbitting forge	2
69	Beader	1
70	Pneumatic pipe clamp former	1
71	30-in. rolls	1
72	Turret punch	1
73	20-in. roll	1
74	No. 2 rip saw	1
75	Punch and shear	5
76	Putnam 36-in. by 18-ft. lathe	18
77	1½-in.-3-in. bolt threader*	19
78	Sensitive drill	20
79	3T triple test rack	27
80	50-ton hydraulic press	15
81	Universal and toolroom grinder	7
82	48-in. radial drill	23
83	24-in. shaper	7
84	Hydraulic gage tester	25
85	6-in. high-speed hack saw	9
86	Wet or dry drill grinder	7
87	42-in. vertical turret lathe	18
88	Small grinder	7
89	3½-in. by 2-in. by 15-in. turret lathe	20
90	72-in. radial drill	14
91	24-in. boring mill	15
92	2-hp. floor grinder	15
93	2-hp. floor grinder	10
94	2-hp. floor grinder	7
95	7½-hp. floor grinder	24
96	7½-hp. floor grinder	21
97	7½-hp. floor grinder	4
98	7½-hp. floor grinder	15
99	7½-hp. floor grinder	11
100	½-in. to 2-in. pipe threader and cutter	8
101	1-in. to 4-in. portable pipe bender	2
102	Internal grinder	14
103	No. 5 plain milling machine	12
104	27-in. piston lathe	13
105	36-in. by 36-in. by 12-ft. milling machine	16
106	16-in. by 66-in. toolroom lathe	6
107	Rotary jacket shear	1
108	Crosshead shoe babbitting form	3
109	Portable cylinder boring machine	9
110	Pneumatic piston bull ring riveting machine	13
111	84-in. boring mill	19

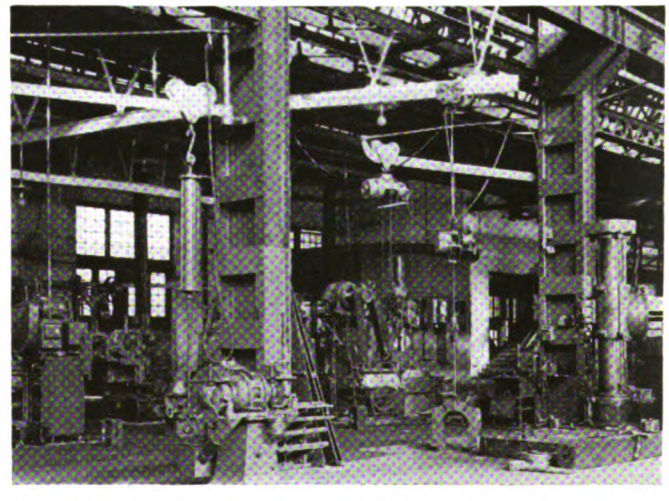
* Belt drive.
† Belt and motor.

boxes, this chuck saving set-up time and contributing to accuracy. A saving of approximately 40 per cent is effected in the machining time required for this operation with the old driving box mill.

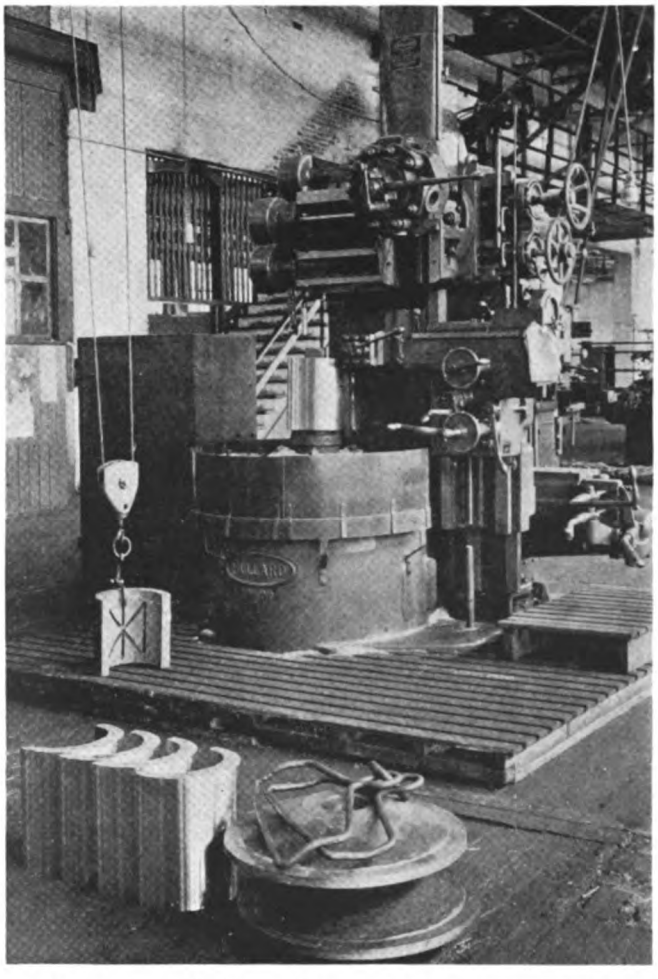
The Bullard 24-in. spiral-drive vertical turret lathe, equipped with a 3-jaw combination chuck and all necessary tool holders, boring bars, cutting tools, etc., is used for manufacturing rod brass bushings, side rod collars, small crown brasses, hub liners, valve bushings, and similar parts.



Micro internal grinder with indexing table for "in-line" grinding of air compressor cylinders



The driving box department is completely equipped for handling parts by monorail and jib cranes with electric and pneumatic hoists



Bullard 42-in. vertical turret lathe used in turning crown brasses, cylinder heads, etc.—Note special lifting devices

This machine saves about 35 per cent in the cost of doing this work over former methods on engine lathes. The machine is a versatile tool, well adapted to production jobs requiring a high degree of accuracy, and also useful on small odd jobs such as turning fibre washers referred to elsewhere in this article.

The uses of the Micro internal grinder are too numerous to mention in their entirety. The machine is well adapted for the accurate and rapid regrinding of air compressor and power reverse gear cylinders, truing side and main rod holes, brass fits, etc. A link-grinding attachment is available to grind any radius up to 100 in. An extra spindle, which finishes 2½-in. to 5-in. holes 13 in. deep, is used for grinding firedoor cylinders, motor car cylinders, etc. New uses are continually developing for this machine and it will doubtless have to be operated on two shifts if and when the shop starts working again at full capacity. Incidentally, double shifting will then be necessary on most of the other new machines.

The Cincinnati No. 5 heavy-duty plain miller, illustrated, is used for general milling operations, being equipped with a 66-in. table to do larger work, such as side rods. The Danville shop was never previously equipped with a milling machine of this capacity and flexibility, and attachments are available for handling many different kinds of work accurately and on a production basis. These attachments include a heavy vertical milling head with one-to-one ratio of spindle speed to that of the main machine. A 24-in. circular milling table, arranged for indexing and power feed, is available. Necessary arbors, spindle nose adaptors, reducing collets, vices and chuck are provided, exceptional care being taken to keep these attachments and tools in the best of condition for immediate use, as in the case of those furnished with the Ingersoll miller.

The American 27-in. by 96-in. heavy-duty engine lathe, installed on the piston and crosshead job, is used in making piston rods, crank pins, and other parts in which the accuracy of this machine, as well as its productive capacity, make it a valuable addition to the shop equipment. The same may be said of the American 6-ft. radial drill installed near this engine lathe. On both machines, an adequate supply of coolant is piped to the cutting tool where it is employed when necessary to use heavier cutting feeds and speeds. On the lathe a built-in chip and coolant pan is provided, also a roller-bearing tail-stock center, dual direct-reading across dials, taper attachment, combination plain block nest with 4-way tool holder, 24-in. 4-jaw independent chuck, chip breaker, etc.

The Pratt & Whitney 16-in. tool room lathe swings 18½ in. over the ways, takes 66 in. between centers and has 18 speeds from 16 to 1,000 r. p. m. The spindle operates in pre-loaded Timken roller bearings. Taper and relieving attachments are provided, also a drawing-in attachment with 15 No. 6 collets, varying from ⅛ in. to 6 in. by sixteenths. The machine is equipped with the usual independent and universal chucks, including a drill chuck with arbor attachment for the tail stock. From the point of view of accuracy, ease of operation, range and variety of work handled, this new lathe so far surpasses the old tool room lathe which it replaced that no real comparison can be made.

The Jones & Lamson 3½-in. turret lathe is used in the general small machine department for making all kinds of brake and spring pins and bushings, studs, bolts, etc. It is an accurate high-production tool which saves at least 25 per cent in time and labor cost, as compared with the worn-out and inadequate turret lathes formerly used. On the present basis of shop operation at Danville, this machine is used on relatively short-run orders, so its real value will not be demonstrated until production picks up and the shop gets back on a normal basis.

The Wallace electric-driven pipe-bending machine, installed in the pipe shop, is used for bending all locomotive pipes, ½ in. to 4 in. in size, by means of suitably-indexed, 4-side holding blocks and an hydraulic ram equipped with a die of the proper size. These pipe bends are made cold, thus saving the cost of delay of heating. The Toledo super-model pipe-threading machine, also installed in the pipe shop, is an important addition, owing to the fact that ½-in. to 2-in. threads are cut on a high production basis, with close tolerances which greatly improve bolt and nut connections. The machine has a pipe cutting attachment and a reamer to remove inside burrs. Die life is increased not only by the quality of tool steel used and its heat treatment, but by the powerful and steady feed and cutter drive. The machine is equipped with six quick-opening die heads and one right-hand pipe die for each size from ½ in. to 2 in.

Ten U. S. electric floor grinders, located at strategic points throughout the shop, tend to minimize extra steps and lost time in handling the many small hand-grinding operations which must be performed in all locomotive shops. Six of these machines are driven by 7½-hp. a. c. motors, each direct connected to an 18-in. by 3-in. grinding wheel and operating at 1,120 r. p. m. The other four grinders have 12-in. by 3-in. wheels operating at 1,750 r. p. m. and driven by 2 hp. a. c. motors. The minimum diameter of hood outlets is 4½ in. in each case.

Cullman individual motor drives have been applied to

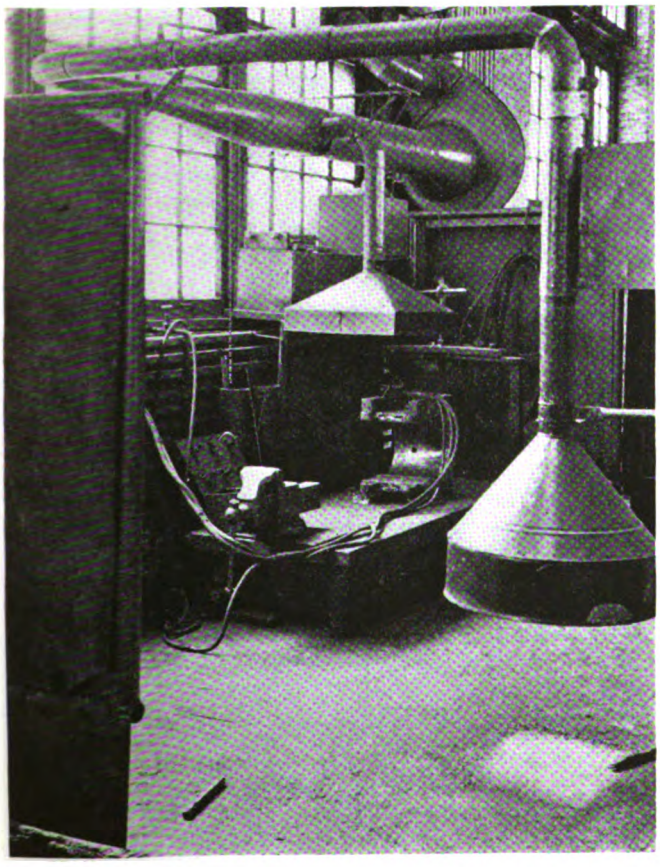
seven lathes, shapers, millers, etc., as shown in the list, replacing overhead line shafting and belts with attendant maintenance cost, loss of power while machines are idle, and lack of flexibility as regards changing machine locations. With individual electric drive, these lathes and other tools have been located wherever they can be placed to best advantage in each shop sub-department.

The five Ingersoll-Rand pneumatic hoists include one of 2-ton capacity and four of 1-ton capacity. These hoists have proved to be fast, accurate and durable, requiring minimum expenditures for repairs.

Each important machine at Danville shops is equipped with a steel locker for the safe and convenient storage of tools while not being used. The provision of a suitable place to hold these tools which is handy to the machine operator saves a lot of time in the aggregate and in addition, much damage and loss of small tools is avoided. With the same objective, floor racks are provided, when necessary, to keep all machine attachments off the floor and also conveniently available. Special wrenches and other tools of large size are kept in ingenious locked racks where they are available only to men authorized to use them.

Welding Booth Equipped with Exhaust Hoods

In addition to the main welding booth in the Danville locomotive erecting shop, a smaller 12-ft. by 14-ft. booth has been installed under the balcony adjacent to the driving box job, where it is used primarily in welding cracked driving boxes, applying Mez metal side bearing liners and also steel shoe and wedge liners. A Lincoln portable 600-amp. welding machine is used in this booth which is equipped with a low steel-covered table to support driving boxes about 18 in. above the floor, and a small rotating plate which is conveniently used to rotate and support the box at floor level when this is desirable.



The welding booth is equipped with a convenient and effective exhaust system

Referring to the illustration, the very compact and efficient exhaust system used in getting rid of noxious gases and fumes is clearly shown. It consists of a 1½-hp. electric motor, direct connected to a 20-in. exhaust fan with an 8-in. intake which tapers down to 4 in. sheet metal pipe connections to the hoods. The feature of these hoods is the fact that they can be easily adjusted up or down and in addition, swung up entirely out of the way when not needed. Slides are provided to regulate the draft.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Distinction between "Working Pressure" And "Allowed Working Pressure"

Q.—Rules 34 and 35 on safety valves in the 1929 edition of the I. C. C. laws, rules and instructions for inspection and testing of steam locomotives and tenders and their appurtenances states in part:

"34. Number and Capacity—Every boiler shall be equipped with at least two safety valves, the capacity of which shall be sufficient to prevent, under any conditions of service, an accumulation of pressure more than 5 per cent above the allowed steam pressure.

"35. Setting of Safety Valves—Safety valves shall be set to pop at pressures not exceeding 6 lb. above the working steam pressure. When setting safety valves, two steam gages shall be used, one of which must be so located that it will be in full view of the person engaged in setting such valves; . . . . ."

In these two rules it will be noted that rule 34 refers to "allowed steam pressure" and rule 35 refers to "working steam pressure." Would you kindly advise me as to what the distinction is between allowed steam pressure and working steam pressure as used in these rules?

Also, the form of the specification card in the I. C. C. rules calls for the maximum stresses for the allowed working pressure while in the affidavit the inspector signs that the boiler is safe for a working pressure. Is there any distinction between "allowed working pressure" and the "working pressure" as used in connection with the specification card and affidavit?—A. L. P.

A.—This question was submitted to J. M. Hall, chief inspector of the Bureau of Locomotive Inspection, who has submitted the following answer:

"The term 'allowed steam pressure' means the pressure fixed by the carrier in conformity with rule 1. This is the pressure upon which the stresses shown on the specification card are based and it must be such that the boiler will have at least the minimum factor of safety of four as specified by rule 2, and the stresses on stays and braces must not be more than the maximum permitted under rule 3.

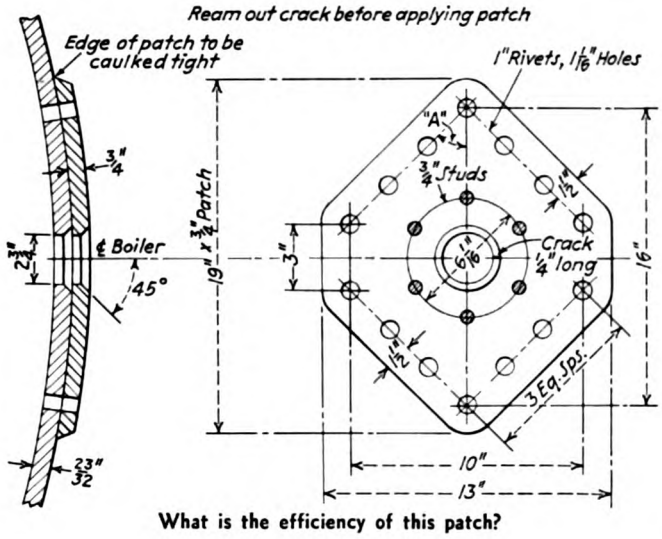
"The term 'working steam pressure' means the maximum nominal pressure at which the boiler is operated, and is likewise fixed by the carrier; it may be the same as the 'allowed steam pressure' or less, depending on the option of the carrier. The specification card may

be compiled, if desired, on the basis of the lower pressure, and in the event it is later desired to increase the pressure, this may be done after proper tests and inspections are made and required reports filed."

The Efficiency of a Patch For a Boiler-Check Hole

Q.—What is the efficiency of the boiler-check patch shown in the accompanying illustration?

A.—An examination of this patch indicates that its lowest efficiency will be along the outside row of rivets.



What is the efficiency of this patch?

The efficiency along the outside row of rivets is determined by the formula

$$E = \frac{2\,(p - d)}{p\sqrt{3\,(\sin A)^2 + 1}}$$

where E = efficiency; p = diagonal pitch, in., and d = diameter of rivet hole, in. From the drawing:

$p = \frac{\sqrt{(5^2 + 6.5^2)}}{3} = 2.73$ in., and $\sin A = 5/8.2 = 0.6097$. Substituting these two values in the foregoing formula, we have

$$E = \frac{2\,(2.73 - 1.0625)}{2.73\sqrt{3\,(0.6097)^2 + 1}} = \frac{3.335}{3.9585} = 0.842.$$

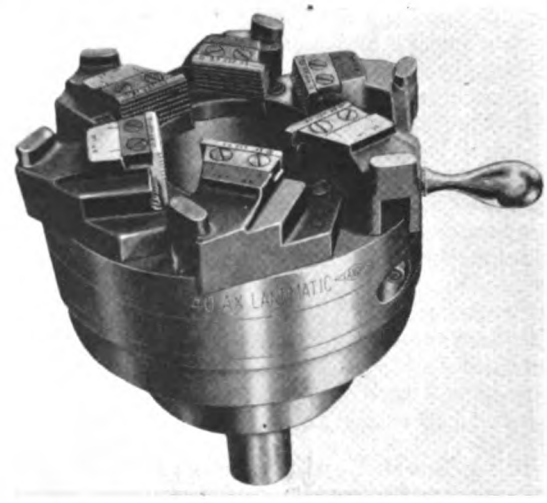
Therefore, the efficiency of the patch is 84.2 per cent.

Die Head for Large Diameter and Long Threads

The Landis Machine Company, Waynesboro, Pa., has added to its line of threading equipment the illustrated 40AX Landmatic die head for threading large diameters of long thread lengths. The diametral capacity of the head is 4 in. to 5⅛ in. with a pitch range of 7 to 20 threads per in. Thread length, while not unlimited, is sufficient to take in a large range. The head illustrated has a thread-length capacity of 7 in. on a 5⅛ in. diameter.

The die head belongs to the Landis Landmatic series and is of the self-opening, pull-off type for application to turret lathes and hand-operated screw machines. It is heat-treated throughout and ground for maximum wearing qualities. Diametrical graduations on the circumferential surface and micrometer graduations on the adjusting screw are used to insure rapid and accurate size changes.

The 40AX head carries six chasers mounted on the face of the head similar to the four-chaser die head. By using six chasers instead of four, the cutting load is more widely distributed. Thus, the working parts of the head as well as the part being threaded are subject to less cutting stress. This is said to result in an increase in tool life with more threads obtained per grind of the chaser, improved quality of the product being threaded, and also an increase in the life of the die head.



The Landmatic 40AX die head with a diametral capacity of 4 in. to 5⅛ in. with a pitch range of 7 to 20 threads per in.

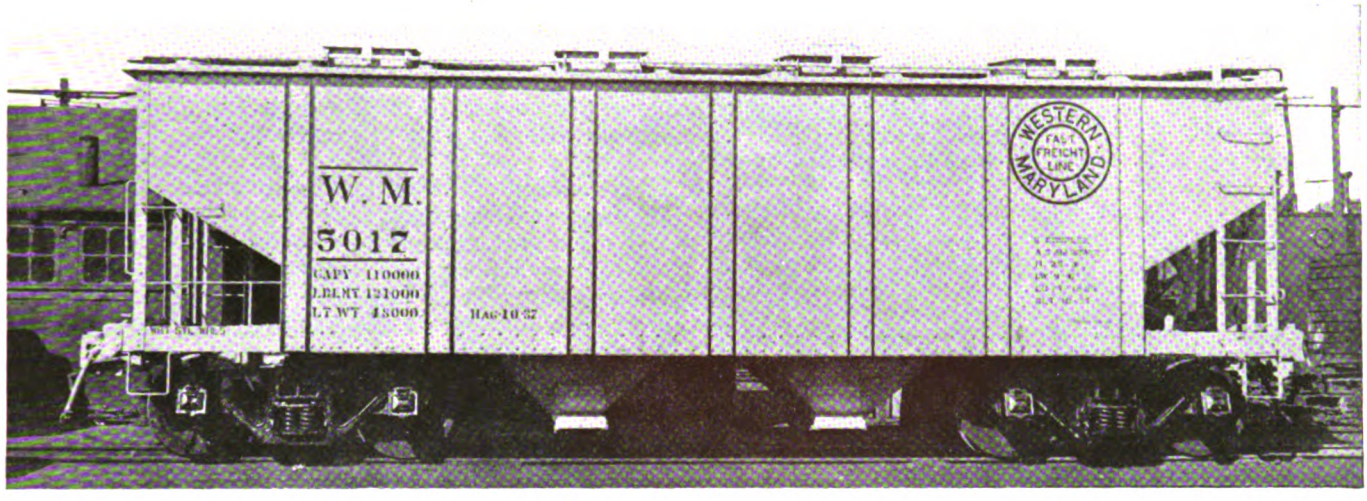
Electrode for Parts Subject to Heavy Impact

The Harnischfeger Corporation, Milwaukee, Wis., announces an addition to its line of Smootharc welding electrodes which is called "Harmang." Designed for welding on parts subject to heavy impact, these electrodes supply the necessary toughness and hardness demanded. Its base metal is nickel-manganese steel, ranging from 11 per cent to 14 per cent nickel-manganese, and 3½ to 4½ per cent nickel. Carbon content is in excess of one per cent.

The slag coating which stabilizes the arc and protects the metal against loss of carbon and manganese is kept to a minimum so as not to interfere with the rapid cooling required to form an austentitic deposit. With cold working, such as hammering and peening, the soft manganese deposit becomes an extremely hard martensite layer which offers great resistance to impact and abrasion. Harmang operates with the work negative and the electrode positive, and is built in sizes from ⅛ in. to ¼ in. diameter for use with currents ranging from 90 to 140 amp.

A Famous Railroad—Arkansas has the world's most famous railroad. It goes through the Dardanelles (Dardanelle, Ark.), it crosses the Delaware (Delaware Creek), it is in sight of London (London, Ark.), it passes through Subiaco, where is located a monastery named after the one in Italy, and terminates at Paris (Paris, Ark.). The name of this railroad is the Fort Smith, Subiaco & Rock Island.

With the Car Foremen and Inspectors



The completed bulk-cement car

Coal Hoppers Converted To Bulk-Cement Cars

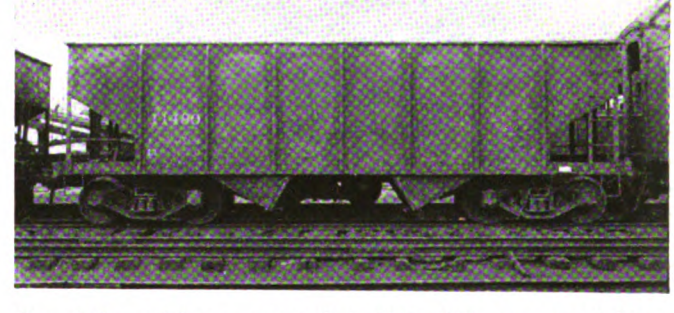
The Western Maryland recently constructed 20 all-steel bulk-cement cars on basic parts salvaged from dismantled coal hopper cars. All body sheets in contact with the lading are new, and all rivet heads on the inner side are countersunk to give a smooth surface for the free discharge of cement. In addition to riveting, all inside seams are welded to increase rigidity of the car body and guard against possible development of crevices through which cement might escape. The inside of the car body was not painted, but was sandblasted to remove all roughness and scale. The exterior of the car body is painted with a special alkali-resisting cement car paint, of approximate cement color, so that a neat appearance can be maintained with a minimum expense. The general dimensions, weights and capacities of the cars are given in the accompanying table.

General Dimensions, Weights and Capacities of the Bulk-Cement Cars

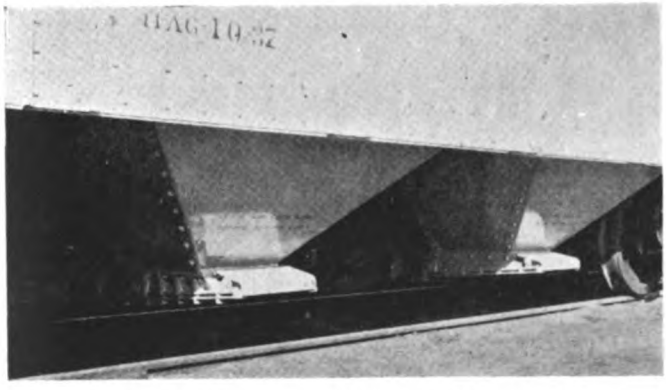
Length inside, ft. and in.	25- 9
Length over striking plates, ft. and in.	32- 3
Length over pulling face of couplers (normal), ft. and in.	34- 9
Length over running boards, ft. and in.	32-11
Truck wheel base, ft. and in.	5- 6
Width inside, ft. and in.	9- 6
Width over roof eaves, ft. and in.	10- 3
Height from rail to top of roof hatches (highest point), ft. and in.	11- 8½
Height from rail to center-plate bearing surface, ft. and in.	2- 3¾
Height from rail to center of couplers, ft. and in.	2-10½
A. A. R. Load limit, lb.	169,000
Light weight, average, lb.	48,000
Live-load limit, lb.	121,000
Volumetric capacity, cu. ft.	1,425
Cement capacity @ 85 lb. per cu. ft., lb.	121,125
Lump-lime capacity @ 65 lb. per cu. ft., lb.	92,625

The coal hopper cars, built in 1916 and 1917 of conventional design, were in a worn-out condition in 1937, with obsolete draft gears and couplers, air brakes, hand brakes and door fixtures, and were due for complete rebuilding, to either a modernized car of the same or other type. In this case, 20 cars were rebuilt to a design suitable for shipment of bulk cement, to handle anticipated traffic requirements along that line. The rebuilt bulk-cement cars are the result of a studied effort to please both the cement companies and the receivers of shipments of bulk cement. When these cars are loaded, the cement is usually pumped from the silos to the roof hatches, through a hose about 8 in. in diameter, and it is necessary that the hatches be of a height, dimensions, and arrangement suitable for this operation, and the discharge gates must be adapted to standard unloading facilities. The cement is loaded in an aerated fluid condition, but becomes compact from the vibration in transit, and on this account the cars were built as smooth as possible inside, and the slope sheets were given an angle of 44 deg. to aid in speedy unloading of the compact cement at its destination.

The coal hopper cars were dismantled as far as required for the new construction, and in addition, removal was made of parts requiring repairs or renewal on account of bad condition. The underframes were thoroughly examined for cracks or distortions, and repaired when necessary. Center sills were reinforced by the addition of a heavy one-piece top cover plate extend-



One of the coal hopper cars built in 1917 which was converted to a bulk-cement car



The discharge hoppers with Wine discharge gates



The cement cars are equipped with Chicago-Hutchins Dry-Lading steel roofs and water-tight hatches

ing full length; also, they were reinforced at each end with bottom cover plates between the hoppers and bolsters. The center sills were adjusted and repaired when necessary and made ready for the application of cover plates. Bolsters, end sills and end sheets were reapplied when found in suitable condition for further service; otherwise, they were renewed.

The trucks were completely dismantled, every detail inspected and defective or worn parts renewed or repaired. They were originally equipped with integral cast-steel side frames, cast-steel bolsters, Barber lateral motion device and Stucki roller side bearings. They were improved by the application of Creco brake-beam safety guards, Creco bottom-rod guards and Wine brake balancers. The brake balancers connect the truck dead levers to the center sills, and relieve the truck bolsters of the eccentric thrust that results from brake applications when the lever is connected in the usual way to the truck bolster. The balancers were installed to reduce wear on wheel flanges and treads, side frames and bolster guides, variation in brake-shoe pressure when the truck swivels, downward loading on brake beam at the end of the car, and tendency for a light car to derail when brakes are applied.

All the dismantling and reconstruction previously described was completed in the outside car yard. The cars were then removed to the erecting shop, for application of side sheets, floor and hopper sheets, air brakes and other specialties, including the roofs, which were applied after the internal welding had been completed. Each car was then returned to the car yard for painting, air brake test, and final inspection before being placed in service by the railroad.

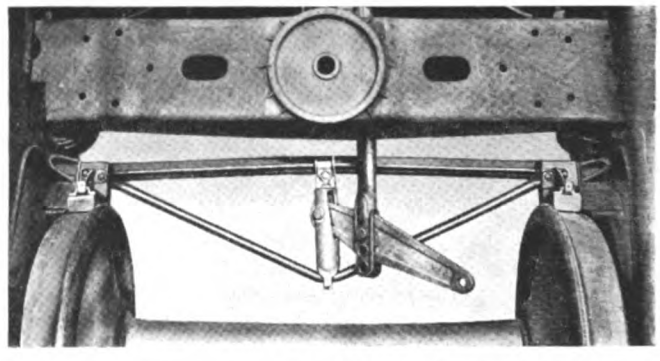
The inside hopper sheets and longitudinal hood were assembled in one piece and placed in position astride the center sills as a single unit. This unit is secured to the center sills at 10 different points by 38 rivets. When assembled, the rectangular tapered hoppers were too rigid to permit adjustment for the application and alinement of the Wine discharge gates with which the cars are equipped. For this reason, the discharge openings were fitted and bolted to a jig, which held them in the correct position until after the seam rivets were driven. The cement car has a center bulkhead made of a single ¼-in. plate, reinforced at the top by bulb angles and at the sides with heavy connecting angles securely riveted to the sides and hopper slope sheets. This bulkhead serves as a crosstie and lateral brace, and divides the lading so that one end of the car can be completely unloaded without disturbing the opposite end.

The car roof is of all-steel Chicago-Hutchins Dry-Lading design. The hatches are sufficiently high to prevent water entering the car; when sealed with the locking rods used, they are entirely waterproof.

Other specialties used with the car are Ajax hand brakes, Miner A-22-XB friction draft gears, Farlow draft gear attachments, A. A. R. Type-E couplers, and AB brakes, furnished by Westinghouse.

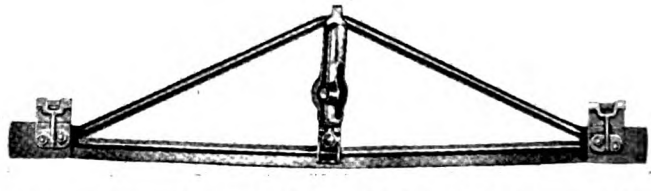
Report of Test With Unit Trucks

The Unit Truck Corporation, Jersey City, N. J., reports the completion of a test of its Unit Truck in 24-hour mill switching service on the South Buffalo Railway, Buffalo, N. Y. Unit Trucks, with a foundation-brake arrangement which has no brake-beam hangers, brake-beam supports or adjusting devices, were installed on



Foundation-brake arrangement of the Unit Truck—The brake-beam guides are cast integral on the inside of the frame

May 1, 1937, on the tender of the South Buffalo locomotive No. 30, and on May 2, 1938, after 80,000 brake applications had been made, it was found that the average wear on the brake-beam wear plates was but 1/64 in. Even and full brake-shoe wear and improved braking efficiency were reported throughout the test with satisfactory performance of the trucks and brakes



The brake-beam wear plates at the ends of the brake beam wore less than 1/64 in. during 80,000 brake applications

during the severe winter weather encountered during the test.

The Unit Truck differs from the conventional truck in that brake-beam guides are cast integral on the inside of the tension member of the cast-steel side frame adjacent to the car wheel with an opening into the side-frame window. They slope at an angle of approximately 12 deg. to the center line of the axle. The bottom section of the guide is a continuation of the spring seat.

Both the side-frame guides and the brake-beam bearing surfaces are protected by spring-steel wear plates which can be replaced when necessary. This foundation brake has 116 less parts and weighs 200 lb. per car less than previous designs. It was described completely in the June 21, 1937, Daily edition of the Railway Age. p. 1040D32.

Decisions of Arbitration Cases

(The Arbitration Committee of the A.A.R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Car Destroyed by Fire When Located at Interchange Point

On January 10, 1936, the Union Pacific delivered to the Wabash on the recognized interchange track in the North Kansas yards of the Wabash, an ASIX tank car loaded with gasoline. After arrival on the interchange track, the car was found to be leaking at the bottom outlet extension and was set on the light repair track in the North Kansas City yards for repairs, where it caught fire and was destroyed.

The Wabash produced evidence showing that the bottom outlet extension was in bad order and maintained that the car was leaking when delivered to the interchange track. It further maintained that the car was not accepted by the Wabash inspectors, but that it could not be refused and therefore was removed to the nearest available point for repairs according to I. C. C. Bureau of Explosives rules, Pamphlet 20-J, paragraph 690, also section (b) of A. A. R. Rule 2.

The U. P. contended that the leak started after the car had been placed on the interchange track and reported that the interchange inspection report signed by the Wabash inspectors did not show that the car was to be rejected, but that it was to be shopped for repairs. The U. P. also pointed out that after the leak was discovered, the nearest repair tracks was on its own line, rather than on the Wabash. It produced evidence showing that the car was set on the interchange track at 9:30 a. m., was picked up by the Wabash and delivered to the repair track about 3:25 p. m., and repairs to the car were not started until 5:30 p. m., indicating that the Wabash repairmen considered the leak of no consequence. After repairs were started, the cap on the extension outlet fell off permitting the gasoline to gush forth, which caught fire and destroyed the car. The U. P. further pointed out that under a local interchange agreement, the car was in possession of the Wabash.

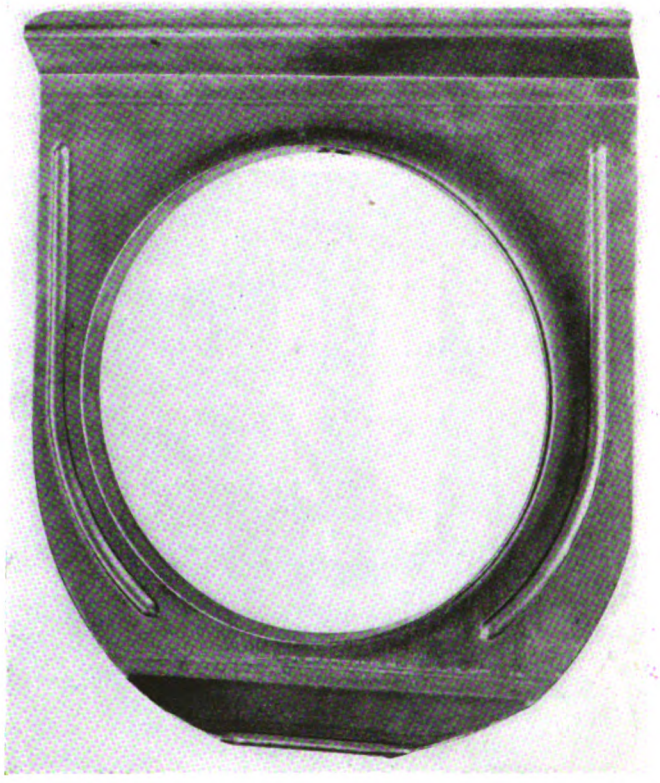
The Arbitration Committee stated in a decision rendered December 30, 1937, that: "The Wabash is responsible for destruction of the car, same being in its possession at time fire occurred."—*Case No. 1758, Wabash versus Union Pacific.*

Apex All-Metal Dust Guard

A new type of all-metal dust guard, designed to function effectively in retaining oil in freight-car journal boxes and keep dust and water out, has been given extensive service tests and is now being sold by the Apex Railway Products Company, Chicago. Special features of this dust guard include simplicity, ease of application without the use of special tools, long service life and the possibility of subsequent reapplication.

The Apex dust guard is pressed in one piece from 16-gage Long Terne (lead coated) steel. Spring-tension flares formed at the top and bottom of the dust guard allow for variation in well thickness and hold the guard firmly against the inner surface of the dust-guard well. The taper-flanged center hole has a clearance of $\frac{1}{64}$ in. over the axle size and this design eliminates binding, since the taper flange allows ample angular movement of the car axle while negotiating curves. Small vertical ribs pressed on each side of the dust guard contribute additional stiffness and strength.

With a fixed clearance of $\frac{1}{64}$ in. between this dust guard and the axle, the oil itself acts as a seal at this point to exclude dust and dirt. The guard fits snugly against the face of the well, making it possible to maintain the proper oil level for efficient lubrication. Being



Apex one-piece dust guard made of Long Terne (lead coated) steel

supported under its own spring tension, the dust guard is self-centering, thus compensating for axle movement and the wear of journal-box parts, as well as enabling

journal boxes to be jacked up for the removal of defective brasses without damage to the guard.

Dust and water are said to be entirely eliminated from the journal bearing by the use of this dust guard. Even when the plug is missing from the top of the well, protection is afforded the journal and bearing by the close contact between the upper flared portion of the dust guard and the well. This flare is designed to divert dust, dirt or water to the sides where it falls harmlessly to the bottom of the well.

The Apex dust guard, being made of heavy-gage metal, is not affected by excessive heat in the journal box nor by any water which might be applied to extinguish a hot-box. It will, therefore, not become charred or water-soaked and can always be removed intact, without difficulty. This dust guard is made in three sizes for axles having the following journal sizes: 5 in. by 9 in., 5½ in. by 10 in., and 6 in. by 11 in.



Two sets of special dies conveniently set up in the Ajax No. 10 bulldozer

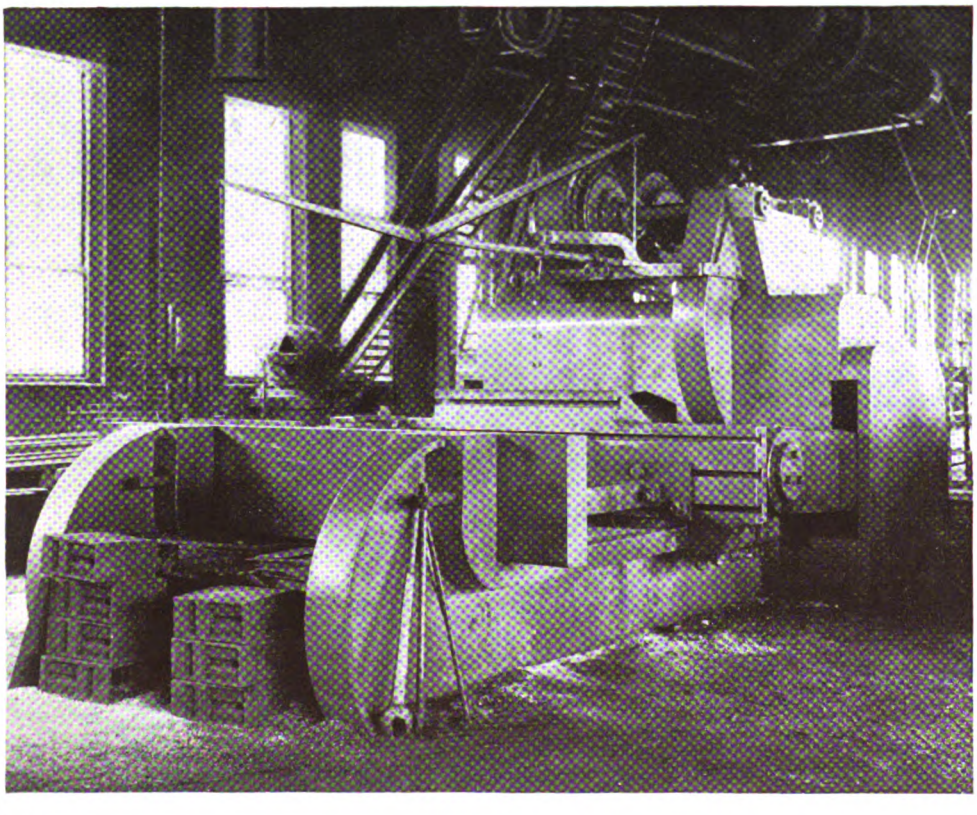
New Bulldozer Expedites Car Work

Many bending and forming operations on steel car parts are now done with speed and precision at the Chicago & North Western car blacksmith shop, Chicago, on a new Ajax No. 10 steel-frame bulldozer which is notable not only for ease and flexibility of operation but for the variety of work which can be done on it. This work includes such operations as bending cold in one operation the 4¾-in. radius flange on 4-ft. by 6-ft. ore car doors, shaping underframe crossbearers, pressing the offset in passenger-truck pedestal plates, making the flanges on baggage-car striking blocks and bending all shapes and sizes of truck braces and hangers.

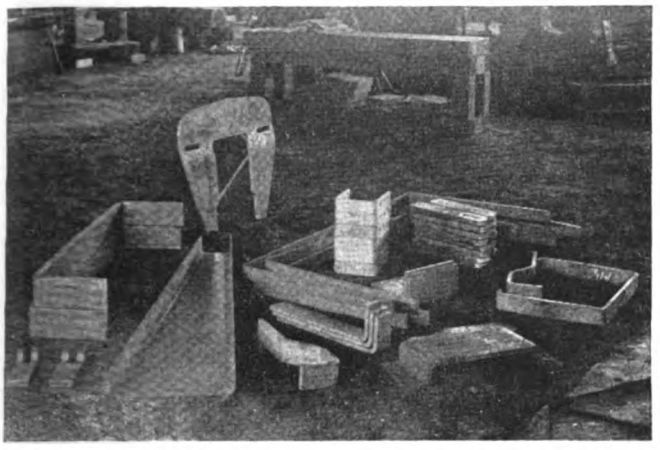
The new Ajax bulldozer, which replaces an obsolete and worn-out machine, is driven from a 30-hp. alternating current motor through dual reversing clutches, with electric controls conveniently located. One of the most important advantages of the machine from the point of view of shop production is that the heavy crosshead, with outboard guide bearings, can be stopped or reversed at any point in the stroke. Both clutches are operated from a rock shaft above the die space with horizontal levers extending to either side of the machine. A band brake of liberal diameter stops the machine with both clutches in neutral position.

A clutch and brake-timing mechanism permits operating the bulldozer automatically on single stroke, the operator merely engaging the clutch for starting. The timing mechanism can be made inoperative so as to require engagement and disengagement of the clutches manually. The multiple-disc type clutches provide an efficient overload protection by slipping when overloaded.

Improvements in the new bulldozer include, in addition to the welded steel frame and rear extension guide bearing for the crosshead, the use of Trunion type main gears. The provision of reversing individual motor drive without the use of bevel gears is also an important ad-



Ajax No. 10 motor-driven steel-frame bulldozer installed at the C. & N. W. car blacksmith shop, Chicago

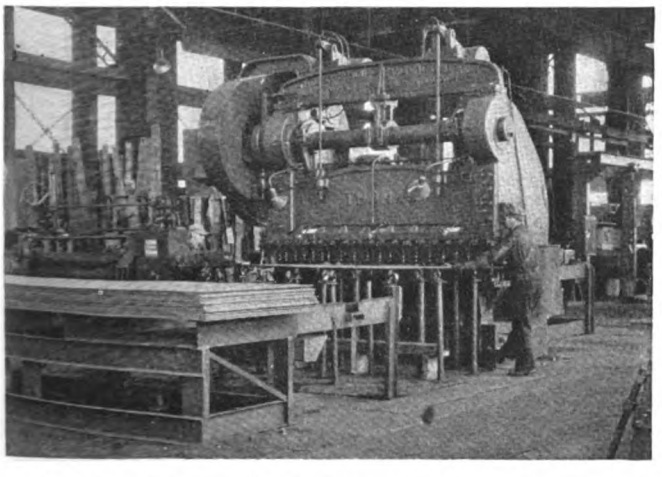


The work done on the bulldozer includes the forming of underframe crossbearers, passenger-truck pedestal plates, baggage-car striking blocks, and truck braces and hangers of all shapes and sizes

vantage. The crosshead face, provided with conveniently located T-slots for attachment of the moving die, is 108 in. by 20 in. and 34 in.; crosshead traverse, 30 in.; die space, with crosshead forward, 66 in.; height of resistance lugs, 21 in.; crosshead strokes, 7 to 8 per minute; floor space, about 18 ft. by 19 ft. and approximate weight, 75,000 lb.

Multiple Punch Speeds Repairs to Steel Cars

The Louisville & Nashville recently modernized its South Louisville steel-car shop by relocating existing facilities and installing new equipment, which have made possible a shop capacity of 35 rebuilt cars per day. Among the



Punching 23 holes on one side of a hopper-car floor sheet in one operation with the Thomas 600-ton multiple punch

new equipment installed was the illustrated 600-ton multiple punch which is capable of punching four $1\frac{1}{16}$-in. holes in 1-in. plate, or as many as 62 holes of $\frac{9}{16}$ in. diameter in $\frac{1}{4}$-in. plate at each stroke of the ram. Sheets up to 10 ft. 6 in. wide, 1 in. thick, and of any standard length can be worked with ease. The design of this machine is such that through the proper setting and manipulation of the punches, which are locked and unlocked with sliding keys, whole sheets requiring as many as 50 or 60 holes can be completely punched in from three to four strokes of the ram; whereas, with the old equipment used for this work the same sheets may have required from 50 to 60 strokes.

The multiple punch is 15 ft. 5 in. high and 15 ft. 6 in. wide. It has a ram length of 10 ft. 3 in. and is equipped with punching tools arranged in double rows with 50 separately adjustable punching units. It is operated by a 20-hp. 230-volt d. c. motor having automatic remote control.

The punch is predominantly a production machine and effects its greatest economy of operation when doing production work. The highest efficiency of operation is obtained when it is possible to handle successively as many as 100 or more sheets with identical perforations between die set-ups. Thus, the machine is arranged with its accompaniment of dies so grouped that the complete punching of each sheet is done with the least number of operations and the minimum of handling, the sheet being completed from start to finish and ready for application when leaving the punch. It has been used for punching rivet holes in floor sheets, end sheets, side sheets, hopper slope sheets, crossridge sheets, and longitudinal hoods. The multiple punch is made by the Thomas Machine Manufacturing Company, Pittsburgh, Pa.

Questions and Answers On the AB Brake

Brake Cylinders (Continued)

293—*Q.—Which connection on the test device should be attached to the brake-pipe hose on the car?* A.—The connection marked "BP".

294—*Q.—What should be done at the opposite end of the car under test?* A.—A dummy coupling should be placed in the hose and the angle cock opened.

295—*Q.—Why is this done?* A.—To include the air hose and fittings on that end of the car in the test.

296—*Q.—What next should be done?* A.—Open the angle cock on the end of the car at which the test device is connected, moving the test device handle to position No. 1 and charging the brake pipe and reservoirs to 70 lb.

297—*Q.—How long does it generally require to charge up a car?* A.—From 8 to 10 min.

298—*Q.—How may it be determined whether or not the reservoirs are charged to the brake-pipe pressure?* A.—Move the device handle to the lap position. If the brake-pipe pressure drops, the reservoirs are not charged.

299—*Q.—What is the first test to be made?* A.—The application test.

300—*Q.—How would you proceed to make this test?* A.—Lap the device handle for 5 sec. to determine if the equipment is fully charged, then move the handle to position No. 4. When the brake starts to apply, return to lap position.

301—*Q.—How much brake-pipe reduction should be required to obtain a brake application?* A.—Not more than 3 lb.

302—*Q.—After the device handle has been placed on lap, does the brake-pipe pressure remain constant?* A.—No. The pressure continues to drop until the quick-service limiting valve closes.

303—*Q.—What should be the total drop of brake-pipe pressure to accomplish this?* A.—The total drop should not be less than 4 lb.

High Spots in Railway Affairs . . .

Too Many Economic Illiterates

There is much misunderstanding in the railroad field about the wage question and its relationship to the welfare of both the workers and the stability of the railroad industry. With one-third of the railroads in bankruptcy and one-third more virtually bankrupt, the situation is exceedingly precarious. Dr. Harold G. Moulton of the Brookings Institution, recently made an address on technology and economic progress before the Engineering Society of Detroit. His closing words are worthy of careful and critical consideration. "In laying emphasis upon the need of reducing wage rates at the present juncture," he said, "I want to emphasize that this is the one means of expanding the weekly earnings of labor. We have to take our choice between high wage rates and prices, accompanied by low aggregate wages and low volume of production, and lower wage rates and prices, accompanied by expanding production and expanding annual wages and profits. The simple truth is that wage rates, prices and productivity got seriously out of balance in 1937. The balance must be restored if we are again to go forward on a sound basis and on a broad economic front. Only by thorough-going readjustments in the wage-price equation shall we be able to proceed to the realization of the higher standards of living which are so urgently required."

A Reasonable Program

Congressman Samuel B. Pettengill, Democrat from Indiana, spoke at the May meeting of the New York Railroad Club on What's Ahead for the Railroads—The Future of the Iron Horse, prefacing his address with the statement that "For five years the Administration has done nothing about a thoroughly bad situation except to loan the railroads deeper into debt and provide them with more bankruptcy facilities." He made the following suggestions as to what should be done to give relief in the interests of both the railroads and the public:

Stop government competition. Sell the Federal Barge Line.

Stop subsidizing railroad competitors—at railroad expense.

Pass the Pettengill long and short haul bill.

When railroad facilities are required for the benefit of competitors let the cost follow the benefit.

Stop subsidizing intercoastal ships.

Don't pass the McAdoo bill to repeal tolls on American ships going through the Panama Canal.

Put all freight, mail and passenger rate making for all carriers under one body—railroads, trucks, pipeline, coastwise, intercoastal, Great Lakes and river shipping and aviation.

Restore railroad management to its constitutional freedom in strictly management problems.

Let the managements work out consolidation plans, leaving veto power with the I. C. C.

Repeal land grant contracts except during time of war.

Stop frightening investors with talk of repudiation of contracts in solvent roads.

Political Pressure

Incensed by the action of the railroads in starting the machinery to bring about a reduction in wages, several United States Senators have announced in loud tones that they will block the Wagner-Steagall R. F. C. rail loan bill unless the railroad managements withdraw from their wage reduction program. Incidentally these particular senators are among those that the newspaper, "Labor", has enshrined in its pages. That publication, always harsh in its criticism of the railroads because of what it claims to be over-capitalization, now apparently wants the railroads to go still further into debt in order to continue the payment of the prevailing high wage rates. As one independent commentator suggests, however, it will be folly to borrow money if it is to be expended for operating expenses, thus adding further to the fixed charges without improvement to the plant or equipment and the efficiency of operation. With Congress anxious for political reasons to adjourn at the earliest possible moment, there is apparently little possibility of the passage at this session of the Wagner-Steagall bill, or any worth while railroad legislation for that matter.

Pay Cut Notice Served

Employees of the railroads and the Railway Express Agency were notified on May 12 that the carriers proposed to make a 15 per cent reduction in their basic rates of pay. In 1932, when the railroads were in better financial condition than they are today, the employees voluntarily accepted a wage reduction. If the proposed 15 per cent reduction goes into effect, employees will still be getting more than they were after the reduction in 1932. Co-operation on the part of the employees at this time will, among other things, make it possible for the railroads to take care of some of the pressing equipment maintenance and repair work, which in turn will make possible the recalling to service of some of the furloughed employees. Otherwise, the prospects are for a long, drawn-out controversy, which will postpone aid being given to the railroads at this critical period and may engender much bad feeling. Data compiled by the Railway Age, as reported in an editorial in its issue of May 21, indicates that in 1930 labor received 65.8 per cent of the income, leaving 34.2 per cent for capital. In 1932 the division was, labor 72.3 per cent, and capital only 27.7 per cent. In 1937 labor got 70.8 per cent, leaving only 29.2 per cent to capital. "On the basis of results thus far," says the Railway Age, "labor will receive in 1938 relatively much more and capital much less of what will be available for division than in any other year in the entire history of railroading in the United States."

The railways can't operate and provide jobs without a constant inflow of new capital—and new capital won't come in unless capital already invested gets a fairer share of railway earnings than it is getting now. Good money won't go after bad.

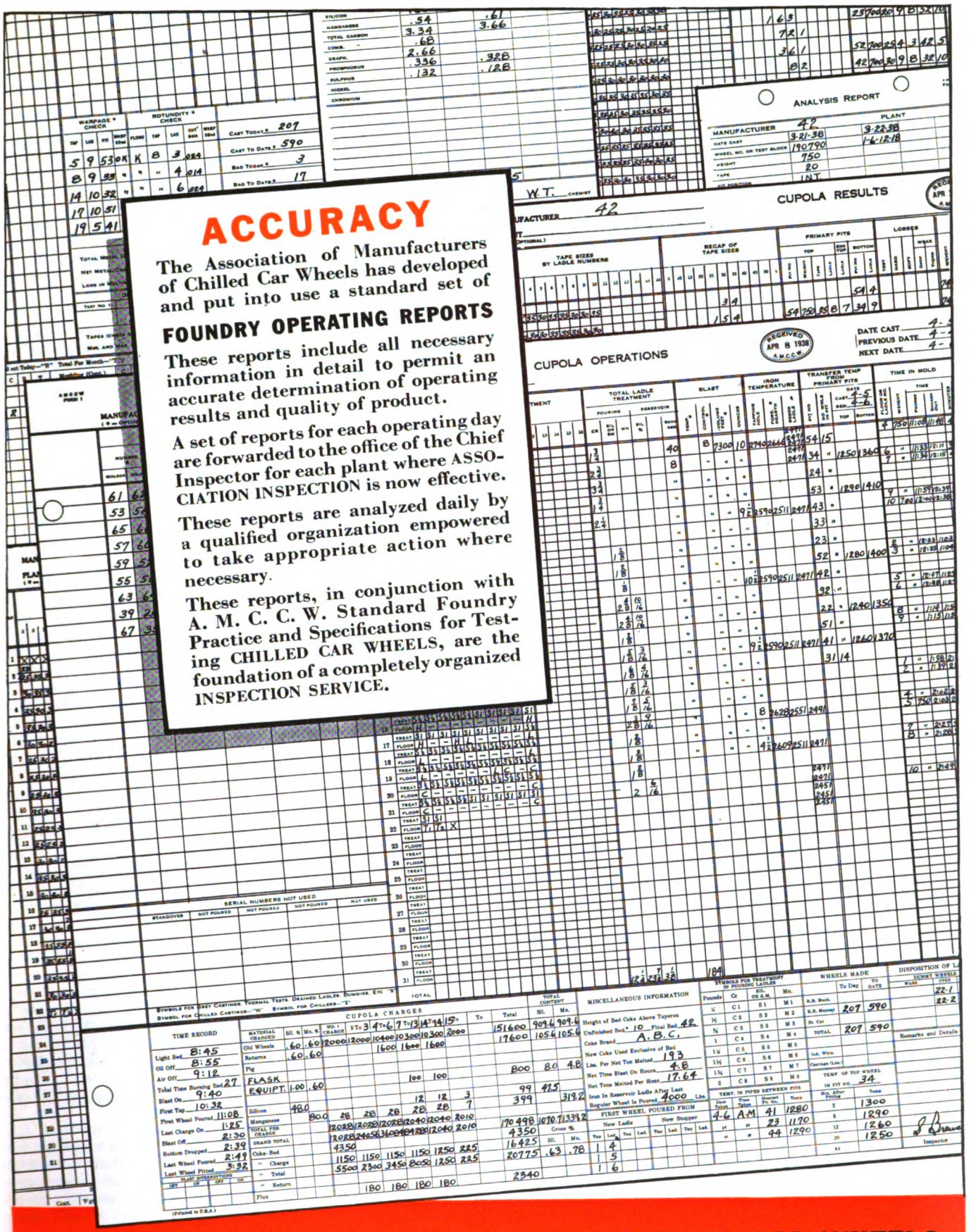
It is a condition and not a theory that railway labor is facing. The question is not how much capital *ought* to get. Rather the question is how much capital has got to be paid to induce it into railroad investment. Unless railway labor agrees to allow capital the minimum earnings which will attract it, capital will stay out of the railroads. And when capital stays out, jobs decline.

The unions can take their choice. They can take so much in wages that capital stays out of the railroads—and jobs will decline. Or they can concede capital a "minimum wage," and money will pour into the railroads and railway employment will increase.

Neglected Step-children

With all its other confusing problems Congress has given little constructive attention during the past month to the plight of the railroads. Considering the seriousness of the railway situation, our solons appear to have been fiddling while Rome was burning. The New York Sun in one of its editorials sized up the situation in these words: "As a matter of simple arithmetic, it must be plain that if the railroads and the electrical utility companies could be put into position to catch up with their arrears of construction, repairs and replacements, there would be little cause for the government to worry about pump priming. But these industries are step-children of current politics; they will get scant consideration so long as a squabbling horde of demagogues can exploit them for vote-catching purposes."

(*Turn to next left-hand page*)


ACCURACY
The Association of Manufacturers of Chilled Car Wheels has developed and put into use a standard set of
FOUNDRY OPERATING REPORTS
These reports include all necessary information in detail to permit an accurate determination of operating results and quality of product.
A set of reports for each operating day are forwarded to the office of the Chief Inspector for each plant where ASSOCIATION INSPECTION is now effective.
These reports are analyzed daily by a qualified organization empowered to take appropriate action where necessary.
These reports, in conjunction with A. M. C. C. W. Standard Foundry Practice and Specifications for Testing CHILLED CAR WHEELS, are the foundation of a completely organized INSPECTION SERVICE.
ANALYSIS REPORT
CUPOLA RESULTS
CUPOLA OPERATIONS
RECEIVED APR 8 1938 A.M.C.C.W.
ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS
445 N. Sacramento Blvd., Chicago, Illinois
230 Park Avenue, New York, N. Y.
AMCCW



*Photographed by W. R. McGee, Livingston, Mont.**

NEWS

R. F. C. Loans

THE Southern has applied to the Reconstruction Finance Corporation for a loan of $14,000,000, the proceeds to be used to purchase "approximately four Diesel-electric or gasoline passenger trains of one or two units each and approximately 5,000 freight train cars." The petition states that the cost of the trains will be $500,000 and the cost of the cars $13,500,000.

Equipment Repair Programs

The Wabash has been authorized by the federal district court at St. Louis to spend $176,700 for general repairs and the application of non-harmonic truck springs to 300 box cars.

The Missouri Pacific will repair 300 fifty-ton box cars at its De Soto, Mo., shops, and upon their completion in August will begin the construction of 100 flat cars.

Locomotives Make High Mileages on "Olympian"

THREE of the new 4-8-4 type combined freight and passenger locomotives delivered early in the year to the Chicago, Milwaukee, St. Paul & Pacific by the Baldwin Locomotive Works have been assigned to handle the Olympian trains of that railroad between Minneapolis, Minn., and Harlowton, Mont., where steam terminates and electric territory begins. Each locomotive makes the entire run between the two terminals, a distance of 1,835 miles per round trip. The three locomotives on this assignment, Nos. 218, 219 and 224, accumulated a total of 55,083 miles during the month of March, or an average of 18,361 miles per locomotive per month.

Locomotive No. 224 made its break-in trip in freight service on February 11, 1938, and during the month of March accumulated 19,282 miles in passenger service between the stations mentioned. Under present operating conditions this is the maximum mileage possible to obtain through this territory on the Milwaukee due to a bridge restriction at Minneapolis and the end of steam-operated territory at Harlowton.

On the east end of the run the locomotives have a layover period of 11 hrs. 15 min., as compared to 18 hrs. 21 min. on the west end. These relatively long layovers are due primarily to the train schedules. Locomotives assigned to this run are handled by six different crews in each direction and no unusual attention is given to them en route. The servicing which the locomotives receive at certain designated stations is practically the same as that required by the 4-6-4 type locomotives previously assigned to handle Olympian trains through this territory.

Mechanical Division Publications

REVISED loose-leaf pages for the Manual of Standard and Recommended Practice of the Association of American Railroads, Mechanical Division, are now available for distribution at nominal cost on application to Secretary V. K. Hawthorne. The 1937 Annual Meeting Proceedings will also be ready for distribution in a short time.

Secretary Hawthorne has been authorized to dispose of the few remaining copies of the report of the Mechanical Advisory Committee to the Federal Co-ordinator of Transportation, issued in 1936. Other reports which may be secured from the secretary include the following: Comparative Impact Tests of Pullman Light-weight Box Car of 1937 and A. A. R. Standard Box Car of 1932; Final Report of Tests of Trucks and Truck Springs; Engineering Report on Air-Conditioning of Railroad Passenger Cars; Report of Road Performance of Air-Conditioned Pullman Sleeping Cars; Report on Relative Performance of Air Filters; and Summary Report on Impact Tests of Light-weight Box Cars.

Equipment Depreciation Rates

EQUIPMENT depreciation rates for seven railroads, including the Detroit, Toledo & Ironton and the Pere Marquette, are prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies. The composite percentages, which are not prescribed rates but merely derivatives of such, for six of the roads are: Kentucky & Tennessee, 3.05 per cent; D. T. & I., 4.13 per cent; Pere Marquette, 4.17 per cent; Ashley, Drew & Northern, 5.66 per cent; Northampton & Bath, 4.26 per cent; El Dorado & Wesson, 13.59 per cent.

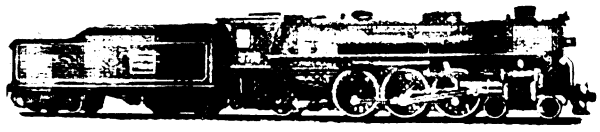
The sub-order relating to the D. T. & I., a modification of a previous sub-order, prescribes rates as follows: Steam locomotives—new, 3.08 per cent; steam locomotives—secondhand or rebuilt, 6.03 per cent; freight cars—new, 3.59 per cent; freight cars—secondhand or rebuilt, 4.12 per cent; passenger-train cars, 5.1 per cent; work equipment, 3.5 per cent; miscellaneous equipment, 16.44 per cent.

The Pere Marquette figure is derived from the following prescribed rates: Steam locomotives—new, 3.42 per cent; steam

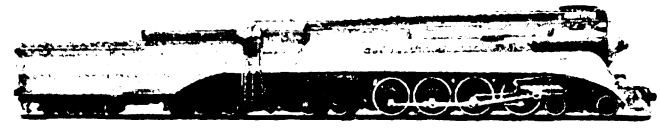
(*Continued on next left-hand page*)

* The third section of train No. 1 on the Northern Pacific westbound on the 1.8 per cent grade three miles west of Livingston, Mont. The train consists of ten cars and is hauled by locomotive No. 5108, a 4-6-6-4 type. The photograph was taken on June 14, 1937. The photographer is a Northern Pacific brakeman.

Passenger Power



Boston & Maine R. R.

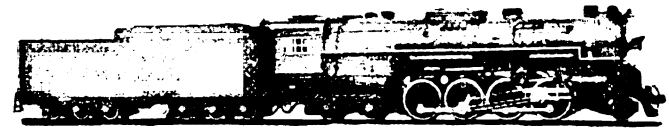


Southern Pacific Company

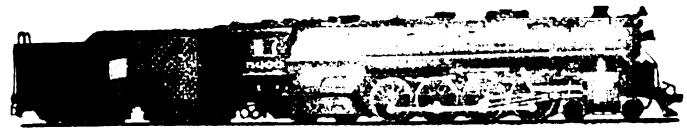
Freight Power



Kansas City Southern Ry.



Pere Marquette Ry.

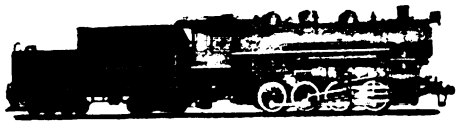


Soo Line

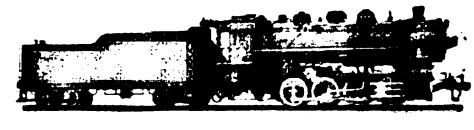
Switching Power



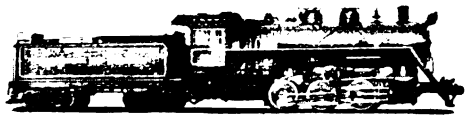
Bauxite & Northern Ry.



New York Central System



Chicago & Illinois Midland Ry.



Youngstown & Northern R. R.



Newburgh & South Shore Ry.

New Lima Built Power

LIMA LOCOMOTIVE WORKS, INCORPORATED, LIMA, OHIO

LIMA LOCOMOTIVE WORKS INCORPORATED

locomotives—secondhand, 4.31 per cent; freight-train cars, 4.5 per cent; passenger-train cars—new all-steel, 3 per cent; other all-steel passenger-train cars, 4 per cent; air-conditioning equipment, 5.42 per cent; floating equipment, 3.21 per cent; work equipment—owned, 3.99 per cent; work equipment—leased, 4.52 per cent; miscellaneous equipment, 10.86 per cent.

Semi-Annual Meeting of A.S.M.E. To Be Held at St. Louis

TECHNICAL sessions of the semi-annual meeting of the American Society of Mechanical Engineers, to be held at the Statler Hotel, St. Louis, Mo., June 20-23, will begin Monday evening, June 20, and continue through Thursday morning. At the luncheon meeting on Tuesday, June 21, Raymond R. Tucker, commissioner of smoke regulation of St. Louis, will tell something of the past, present and future of smoke abatement in St. Louis, and the fourth Calvin W. Rice lecture on Some Metallurgical Contributions to Engineering Progress will be presented by William Robb Barclay, at 4:15 p. m., on the same day. The program contains the following papers of interest to railroad men:

TUESDAY, JUNE 21

Morning

Railroad

Locomotive Axle Testing, by T. V. Buckwalter, vice-president, O. J. Horger, research engineer, and W. C. Sanders, general manager, Railway Division, The Timken Roller Bearing Company.

The Drafting of Steam Locomotives, by J. R. Jackson, engineer of tests, Missouri Pacific.

Noon

Smoke Abatement Luncheon

Afternoon

Railroad

An Oil-Bath-Lubricated Railway Bearing, by Albert Vigne, vice-president, charge of operations, and I. Eugene Cox, research engineer, National Bearing Metals Corp.

Influence of Pressure on Film Viscosity in Heavily Loaded Bearings, by S. J. Needs, research engineer, Kingsbury Machine Works, Inc.

WEDNESDAY, JUNE 22

Morning

Apprenticeship

An Apprenticeship Training Program, by H. L. Humke.

Welding and Flame-Cutting

Oxyacetylene Surface Hardening, by A. K. Seemann, Linde Air Products Co.

Arc-Welding Costs, by E. W. P. Smith, consulting engineer, The Lincoln Electric Co., Cleveland.

$509,793,000 Capital Outlay in 1937

CAPITAL expenditures for equipment and other improvements to railway property made by the Class I railroads in 1937 totaled $509,793,000, according to the Association of American Railroads. This was an increase of $210,802,000 above such expenditures in 1936, but a decrease of $362,815,000 compared with those in 1930.

The increase over 1936 was largely due to heavier orders for new equipment placed by the railroads in the first half of 1937 when indications pointed to a substantial volume of traffic. Due to the decrease in traffic and earnings which developed in the latter months of the year, and the resulting serious financial condition of the railroads, however, there was a marked decline in equipment orders and capital improvements. This situation continues to exist.

Of the total capital expenditures made in 1937, $322,877,000 was for locomotives, freight and passenger train cars, and other equipment, and $186,916,000 was for roadway and structures. In 1936, capital expenditures for equipment amounted to $159,104,000, and for roadway and structures, $139,887,000.

Expenditures for locomotives in the past calendar year totaled $59,738,000, compared with $16,209,000 in the preceding year. For freight train cars, $212,902,000 was expended, an increase of $95,000,000 above such expenditures in 1936, while for passenger train cars, $41,491,000 was expended, which was approximately twice the amount spent for that purpose in the previous year. For other equipment, the railroads in 1937 expended $8,746,000.

Western Railway Club Elects Officers

AT the annual meeting of the Western Railway Club on Monday evening, May 16, at the Hotel Sherman, Chicago, a brief business session was held, just preceding the main address of Clarence F. Lea, national congressman from California, for the consideration of business reports and the election of new officers. The report of the secretary showed a total membership, as of April 22, 1938, of 1,961, including 955 railroad and 912 supply company representatives.

The following officers were elected for the ensuing year: President, E. A. Clifford, general purchasing agent, Chicago & North Western; first vice-president, H. H. Urbach, mechanical assistant to executive vice-president, Chicago, Burlington & Quincy; second vice-president, O. N. Harstad, general manager, Chicago, Milwaukee, St. Paul & Pacific; and treasurer, J. W. Fogg, vice-president and general manager, MacLean-Fogg Lock Nut Company.

Employment Drop Continues

RAILWAY employment fell off another 1.54 per cent during the one-month period from mid-March to mid-April, according to the Interstate Commerce Commission's compilation, based on preliminary reports. The drop as compared with April, 1937, was 19.27 per cent.

The total number of employees as of the middle of April was 913,070 as compared with a mid-March figure of 927,308. In only one group was there an increase over the previous month—maintenance of way and structures forces were up 2.57 per cent, although they were 25.67 per cent under April, 1937. The largest drop as compared with mid-March was in the maintenance of equipment and stores group, which fell off 3.63 per cent; and was down 28.25 per cent from April, 1937. The index number, based on the 1923-1925 average as 100 and corrected for seasonal variation, stood at 51.5 in April, as compared with 53.4 in March and 63.8 in April, 1937.

New Equipment Orders and Inquiries Announced Since the Closing of the May Issue

LOCOMOTIVE ORDERS

Company	No. of Locos.	Type of Loco.	Builder
Boston & Maine	1	600-hp. Diesel-Elec. switcher	Alco
	1	250-hp. gas.-mech. locomotive	Plymouth Locomotive Works
Grand Trunk Western	2	600-hp. Diesel-Elec.[1]	Electro-Motive Corp.
Portland Terminal Co.	1	600-hp. Diesel-Elec. switcher	Alco
Warrior River Terminal	1	900-hp. Diesel-Elec.	Alco

LOCOMOTIVE INQUIRIES

Akron, Canton & Youngstown	3-4	2-8-2	.....
St. Louis & Belleville	2	Electric	.....

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Brazilian Portland Cement Co.	20	10-ton hopper	Magor Car Corp.
Chicago, Milwaukee, St. Paul & Pacific	464	Flat[2]	Company shop
Southern Railway	2,000	40-ton box	Pullman-Standard Car Mfg. Co.
	1,000	40-ton box	Mt. Vernon
	200	50-ton furniture	Mt. Vernon
	50	70-ton M. T. gondola	Mt. Vernon
	1,250	50-ton H. S. gondola	American Car and Foundry Co.
	700	50-ton L. S. gondola	Pressed Steel
	250	40-ton stock	Ralston Steel
	100	70-ton flat	Greenville Steel
United Fruit Company	10	7,500-gal. tank[3]	Magor Car Corp.

FREIGHT-CAR INQUIRIES

American Smelting & Refining Co.	30	40-ton box[4]	.....
Semet-Solvay Company	10	70-ton hopper	.....

PASSENGER-CAR ORDERS

Road	No. of Cars.	Type of Car	Builder
Chicago, Milwaukee, St. Paul & Pacific[2]	55		Company shop
Missouri & North Arkansas	2	Pass.-bagg.-exp. rail motor cars[5]	American Car and Foundry Co.

PASSENGER-CAR INQUIRIES

Seaboard Air Line	6	Lightweight coaches	.....
	4	Lightweight baggage & mail cars	.....

[1] One-hundred ton, eight-cylinder locomotive, for use at Brush Street Terminal, Detroit, Mich.

[2] Material for the 55 passenger cars and the 464 flat cars is now being fabricated. These orders are part of its equipment program to cost $3,000,000, which also includes the purchase of four passenger locomotives, as was noted in the March issue of the *Railway Mechanical Engineer*.

[3] For service in Guatemala.

[4] For service in Mexico.

[5] To be 75 ft. 7 in. in length, with a seating capacity of 32 passengers.

Supply Trade Notes

F. J. DOLAN has been appointed assistant to vice-president of The Superheater Company, with headquarters at New York.

◆

NORMAN C. NAYLOR, vice-president of the American Locomotive Company at Chicago, has been elected also a director.

◆

THE DAYTON RUBBER MANUFACTURING COMPANY, Dayton, Ohio, now has its Chicago office in the Merchandise Mart building, Chicago.

◆

R. J. SCHULER has been appointed general sales representative of the Union Drawn Steel Division of the Republic Steel Corporation, Cleveland, Ohio.

◆

N. B. ROBBINS has been appointed representative of the Hunt-Spiller Manufacturing Corporation, Boston, Mass., to fill the vacancy caused by the death of R. R. Wells.

◆

THE DUFF-NORTON MANUFACTURING COMPANY, Pittsburgh, Pa., has moved its New York sales office from 250 Park avenue to the Empire State building.

◆

J. T. LUSIGNAN, JR., engineering assistant to the vice-president of The Ohio Brass Company, Mansfield, Ohio, has been appointed executive engineer. Mr. Lusignan will supervise all engineering activities of the company.

◆

DAN W. HIRTLE, vice-president of the Burgess Battery Company with headquarters at Chicago, has been elected president to succeed C. F. Burgess, who has been elected chairman of the board of directors.

◆

E. T. CROSS, eastern manager of the Ingot Iron Railway Products Company, Middletown, Ohio, with headquarters at Philadelphia, Pa., has been promoted to general manager, with headquarters at Middletown.

◆

W. R. SPILLER has become affiliated with the Timken-Detroit Axle Company, Detroit, Mich., as sales engineer. Mr. Spiller was chief engineer of the White Motor Company, Cleveland, Ohio, previous to his new appointment with the Timken-Detroit Axle Company.

◆

LEE F. ADAMS, formerly associated with the commercial general department of the General Electric Company, Schenectady, N. Y., has been appointed manager of the company's newly-formed standards department. Mr. Adams will also act as assistant to vice-president E. O. Shreve.

W. E. BETTENDORF, secretary of the Bettendorf Company, Bettendorf, Iowa, has been elected vice-president and general manager, and C. J. W. Clasen, assistant manager of sales, has been appointed sales manager.

◆

B. J. HERRON, for the past 12 years, general representative in the western section for the Independent Pneumatic Tool Company, Chicago, has been placed in charge of a new sales-service branch at 6200 E. Slauson avenue, Los Angeles, Cal.

◆

J. L. NOON, general railway sales manager of the Glidden Company, Cleveland, Ohio, has been appointed manager of its industrial and transportation sales in the United States and Canada, with his headquarters as formerly, at Cleveland.

◆

WILLIAM S. RICHARDSON, merchandising manager of the B. F. Goodrich Company, Akron, Ohio, in its mechanical goods division since 1931, has been appointed general sales manager of the same division, succeeding C. E. Cook, deceased.

◆

C. P. WHITEHEAD, manager of sales of the General Steel Castings Corporation, Eddystone, Pa., has been elected vice-president in charge of sales, and E. G. Hallquist, chief mechanical engineer, has been elected vice-president in charge of engineering.

◆

THE STEEL AND TUBE DIVISION of the Timken Roller Bearing Company, Canton, Ohio, has appointed Joseph T. Ryerson & Son, Inc., Chicago, to warehouse Timken mechanical tubing in territories served by Boston, Mass., Jersey City, N. J., Philadelphia, Pa., Buffalo, N. Y., Cincinnati, Ohio, Chicago, St. Louis, Mo., Cleveland, Ohio, Detroit, Mich., and Milwaukee, Wis.

◆

THE REPUBLIC STEEL CORPORATION, Cleveland, Ohio, has appointed the American Wholesale Hardware Co., Long Beach, Cal.; the Anderson Supply Co., Norwich, Conn.; and the Valley Supply Co., Springfield, Mass., jobbers for its tubular products and Herre Brothers, Harrisburg, Pa., and the Sabine Supply Co., Orange, Tex., distributors for its iron sheets.

◆

THE CELOTEX CORPORATION, Chicago, has acquired full rights to manufacture and sell Pottsco lightweight aggregate, which is made under a patented process by water treatment from molten basic pig-iron slag. Harry H. Potts, president of the Pottsco Corporation, will serve as manager of the Pottsco department of the Celotex Corporation. Production facilities will be maintained at Chicago; Youngstown, Ohio; Buffalo, N. Y., and Troy; and Pittsburgh, Pa., and Birdsboro.

CHARLES L. BROWN, western sales manager of the Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., New York, retired on May 1, at his own request, after 32 years of service. Mr. Brown began work with Manning, Maxwell & Moore, in Chicago, on July 1, 1906, as the company's only representative for the west and mid-west. Under his guidance, a sales organization was developed for this section, and he became western sales manager. Robert Watson succeeds Mr. Brown as western sales manager of the Locomotive Equipment Division, with office in the Field building, Chicago. Mr. Watson was formerly with the Waugh Equipment Company, the Erie railroad and the American Locomotive Company.

◆

WILLIAM P. ANDREWS, assistant manager of sales in the Chicago district of the Carnegie-Illinois Steel Corporation, has been appointed manager of sales of the Cincinnati district, succeeding Lawrence K. Slaback, deceased. T. Lane Watson, who has been in charge of the bar strip and semi-finished materials division of the Carnegie-Illinois Steel Corporation at Chicago, succeeds Mr. Andrews as assistant manager of sales of the Chicago district.

◆

CHARLES B. ROSE, acting works manager of the Baldwin Locomotive Works, at Eddystone, Pa., has been elected a vice-president, and Charles D. MacGillivray, secretary, has been elected a vice-president with headquarters at Eddystone. Walter E. Seymour has been appointed works manager of the Locomotive Division succeeding Charles B. Rose. Mr. MacGillivray will continue also as secretary.

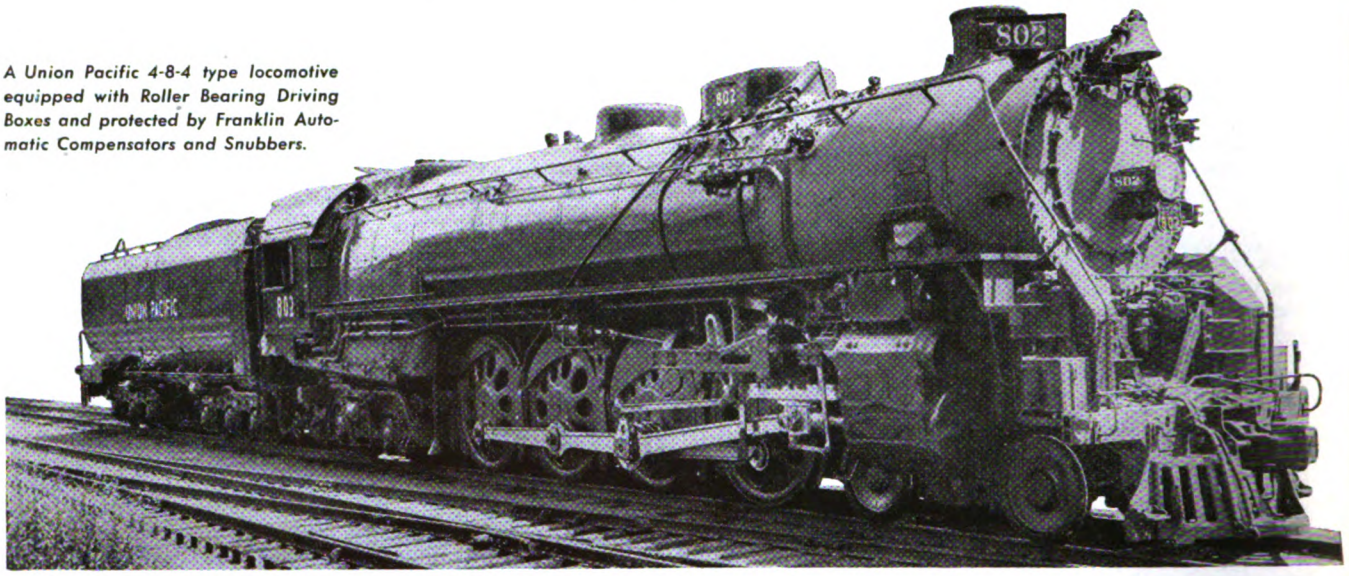
◆

HENRY W. COLLINS, New York sales division manager of the Celotex Corporation, has been elected vice-president and has been succeeded by Harry W. Conway, assistant manager of that division. J. Z. Hollman, assistant general sales manager, has been promoted to general sales manager. Mr. Hollman, who was born in 1896, has been with the Celotex Corporation since 1926. He was formerly branch manager of the St. Louis sales division, and was appointed assistant general sales manager on November 1, 1936. He is a graduate of Washington State College, Pullman, Wash.

◆

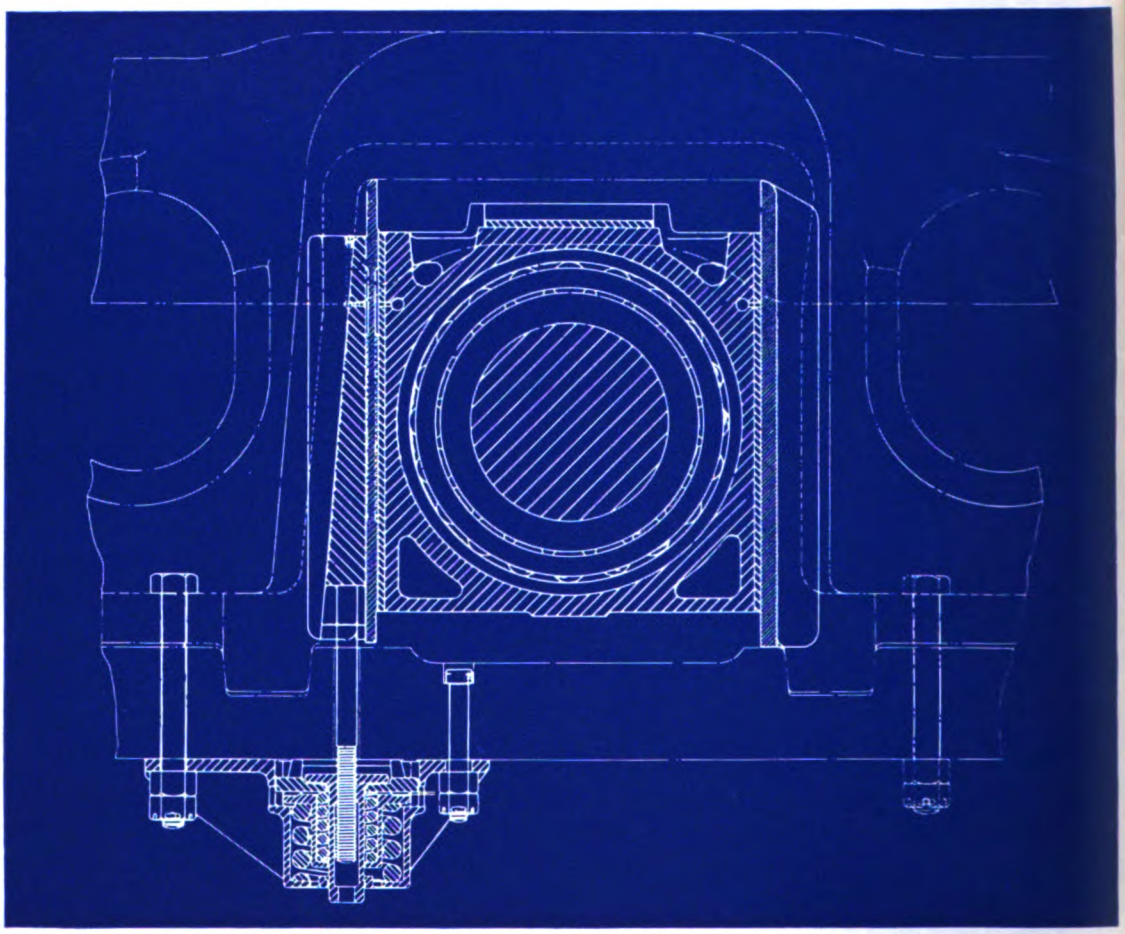
W. ROY WIDDOES, assistant to the president of the By-Products Steel Corporation, Coatesville, Pa., has been appointed general manager of the organization. Mr. Widdoes was born in January, 1895, at Coatesville, and there attended high school. He joined the Lukens Steel Company in 1912, as a clerk. Three years later he went with the Reading Company, but re-

(*Continued on second left-hand page*)



A Union Pacific 4-8-4 type locomotive equipped with Roller Bearing Driving Boxes and protected by Franklin Automatic Compensators and Snubbers.

SLACK and its destructive

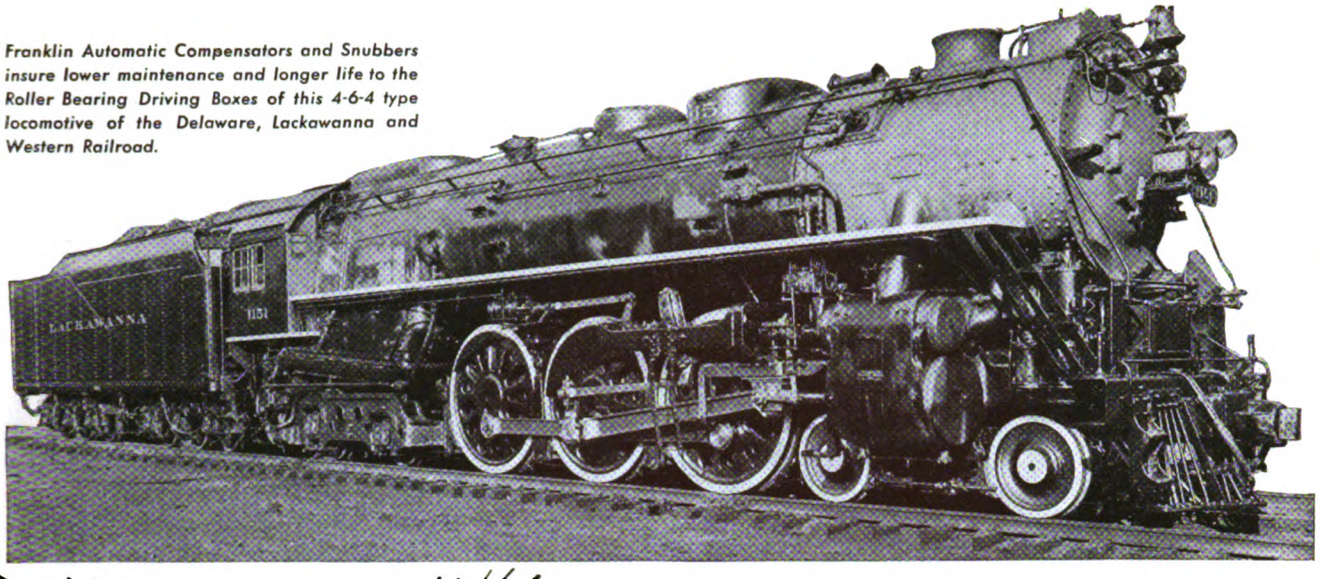


Typical application of Franklin Automatic Compensator and Snubber for Roller Bearing Driving Boxes.

REG. U.S. PAT. OFF.

FRANKLIN RAILWAY

NEW YORK



Franklin Automatic Compensators and Snubbers insure lower maintenance and longer life to the Roller Bearing Driving Boxes of this 4-6-4 type locomotive of the Delaware, Lackawanna and Western Railroad.

POUND is eliminated in these ROLLER BEARING DRIVING BOXES

Roller Bearing Driving Boxes require that the exact initial tolerances be constantly maintained, allowing only a few thousandths deviation for running temperature. The Franklin Automatic Compensator and Snubber is designed to take up automatically any expansion and contraction that occurs in the driving box... while the locomotive is running at road-speed. In addition, a heavy spring acts as a cushion to take care of any abnormal shocks. » » » For lower maintenance, easier riding, prevention of pounds, and reduced tire wear, investigate the Franklin Automatic Compensator and Snubber.

FRANKLIN AUTOMATIC COMPENSATOR AND SNUBBER

SUPPLY COMPANY, INC.

CHICAGO MONTREAL

turned to the Lukens Steel Company the same year to serve in its purchasing department. In 1929 he was appointed assistant purchasing agent and in May, 1937, joined the By-Products Steel Corporation as assistant to president.

◆

PERCY T. OLDHAM has been appointed manager of special sales for the By-Products Steel Corporation, division of Lukens Steel Company, Coatesville, Pa. Mr. Oldham was born in Wheeling, W. Va., in September, 1890. He received his education there and was first employed as assistant county surveyor of Belmont County, Ohio. He was later field engineer of the Wheeling Corrugating Company and the Whittaker Glessner Company at the



P. T. Oldham

Wheeling and Martins Ferry, Ohio, plants, both of which are now a part of the Wheeling Steel Corporation. In 1912 Mr. Oldham became supervising engineer of S. Diescher & Sons, consulting engineers, Pittsburgh, Pa. In December, 1915, he joined the Lukens Steel Company, serving as assistant construction engineer until 1925 when he was transferred to the sales department as manager of flanging sales. Several years later he became engaged in special sales work, in which he remained until his appointment as manager of special sales for the By-Products Steel Corporation. Mr. Oldham is a member of the American Society of Mechanical Engineers and of the Engineers Club of Philadelphia.

◆

A. D. PRENDERGAST, formerly lubrication engineer of the Texas Company, Railway Sales Division, with headquarters at Kansas City, Mo., has been transferred to St. Paul, Minn., as representative of the Railway Sales Division, to succeed A. W. Larsen, who has been appointed assistant district manager, with headquarters at St. Louis, Mo.

◆

J. B. TYTUS has been elected vice-president in charge of operations of the American Rolling Mill Company, Middletown, Ohio, and Frank H. Fanning has been appointed assistant vice-president in charge of operations. Mr. Tytus joined the Armco organization in 1904. He was awarded the Gary medal by the American Iron and Steel Institute several years ago for his part in the development of the continuous rolling process in the manufacture of Iron and steel sheets; and was elected vice-president of Armco in charge of processing developments in 1927. Mr. Fanning entered the organization in 1909 and was associated with Mr. Tytus in 1912 at the Armco mill at Middletown; he later served on numerous special assignments and was appointed assistant to the executive vice-president in 1933.

◆

L. W. MARTIN, of the sales department of the American Car and Foundry Company, has been appointed district sales manager, with headquarters at St. Louis, Mo. Mr. Martin graduated in 1902 from the State University of Kentucky, as bachelor of mechanical and electrical engineering. In the same year he entered the St. Charles, Mo., car shops of the American Car and Foundry Company, where for two years he was engaged in various departmental work. In 1904 he was transferred to St. Louis, and was engaged in engineering, drafting, estimating and de-



L. W. Martin

signing work. His thesis on train lighting obtained for him in 1906 master degree of mechanical engineering at Kentucky University. In 1907 he joined the St. Louis sales office as sales agent for railroad equipment throughout the South. Shortly after the outbreak of the World War, he was transferred to the American Car and Foundry Export Company, a subsidiary of the American Car and Foundry Company. As foreign representative, he traveled in Russia, Siberia, Italy and China on work for the railways of these countries. He returned in 1920 to the American Car and Foundry Company, and resumed sales work. In his new position, Mr. Martin will be in charge of all sales activities under the jurisdiction of the St. Louis office.

Personal Mention

General

ALEX B. COLVILLE, who has been appointed superintendent of motive power of the Great Northern, with headquarters at Spokane, Wash., as noted in May, was born in Scotland on December 22, 1883. He began railway service with the Great Northern on October 25, 1898, as a boilermaker apprentice at Spokane, becoming a machinist apprentice a year later and advancing to machinist in October, 1903. He was made shop foreman of the Hillyard (Wash.) shops in June, 1907, but left the Great Northern in October, 1915, to become general foreman on the Spokane, Portland & Seattle (controlled jointly by the Great Northern and the Northern Pacific) at Portland, Ore. On September 1, 1917, Mr. Colville returned to the Hillyard shops of the Great Northern as general foreman, and on March 1, 1935, was appointed to the position of superintendent of shops at Hillyard which he was holding at the time of his appointment as superintendent of motive power at Spokane.

C. L. WILSON, master mechanic of the Elgin, Joliet & Eastern at Joliet, Ill., has

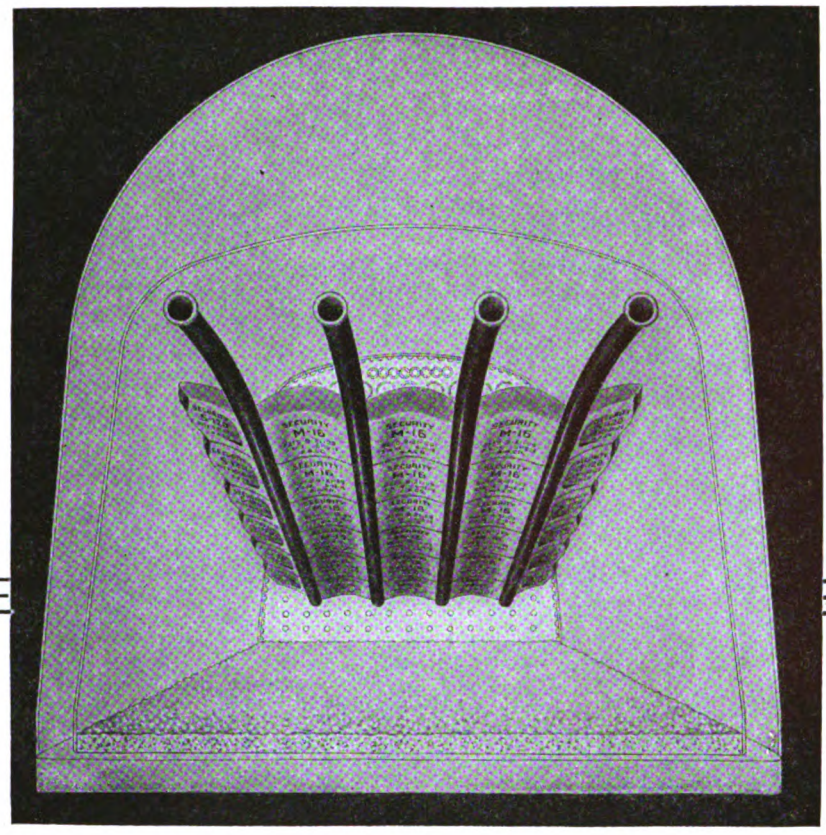


C. L. Wilson

been appointed superintendent of motive power, succeeding J. C. Shreeve, who has retired. Mr. Wilson was born at Joliet, Ill. He entered railway service on November 25, 1897, as a machinist helper on the Elgin, Joliet & Eastern. On March 3, 1898, he became a locomotive fireman, and on January 8, 1903, was promoted to locomotive engineer. He was appointed assistant train rule examiner on September 21, 1918, and traveling engineer on February 1, 1919. Mr. Wilson was appointed air brake supervisor on January 15, 1925, and on August 1, 1933, he was promoted to master mechanic at Joliet, which position he held until his recent promotion.

J. P. MORRIS, who has been appointed mechanical superintendent of the Eastern mechanical district of the Eastern lines of the Atchison, Topeka & Santa Fe at Shopton, Iowa, as noted in the May issue, has

(*Continued on next left-hand page*)



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been identified with the mechanical department of the Santa Fe continuously for 34 years. He was born on March 4, 1889, at Fort Madison, Iowa, and entered the service of the Santa Fe in 1904, as a laborer at that point. Subsequently he served as a machinist and gang foreman, being promoted to enginehouse foreman in 1917. Six years later he became general foreman and in 1924 he was appointed master mechanic with headquarters at Chicago. On July 1, 1937, he became mechanical assistant in the general office at Chicago.



J. P. Morris

G. T. STRONG, assistant superintendent motive power of the Virginian, with headquarters at Princeton, W. Va., has been appointed superintendent motive power, with the same headquarters.

Master Mechanics and Road Foremen

CHARLES JACOB GERBES, who has been appointed master mechanic of the Erie at Marion, Ohio, as noted in the April issue, was born on November 24, 1892, at Hawthorne, N. J. He attended high school for one year and then took the supervisor's training course of the Railway Educational Bureau. He entered the service of the Erie on November 15, 1911, as a machinist at Secaucus, N. J., becoming machine shop foreman on October 1, 1914, enginehouse foreman on February 1, 1916, and general enginehouse foreman on April 1, 1918. On February 1, 1924, he went to Hornell, N. Y., as general foreman in the back shop, and on December 1, 1927, was appointed master mechanic at Hornell. Mr. Gerbes returned to Secaucus on November 7, 1930, as master mechanic; on July 1, 1932, became master mechanic at Avoca, and on March 1, 1938, was transferred to Marion.



Charles Jacob Gerbes

CHARLES W. ECENBARGER, who has been appointed master mechanic of the Erie at Avoca, Pa., as noted in the April issue of the *Railway Mechanical Engineer,* was born on May 17, 1888, at Huntington, Ind. He received his education at common and high schools and entered the service of the Erie on September 1, 1907, as a machinist apprentice at Huntington. Upon the completion of his apprenticeship in 1911 he served in the back shop for a period of two years and in the enginehouse for one year. In 1915 he became night enginehouse foreman; in 1918, day enginehouse foreman, and in 1919, general enginehouse foreman. From December, 1922, until May, 1928, he was night general foreman at Marion, Ohio. He was transferred to Port Jervis, N. Y., on December 1, 1930, as general foreman, and on March 1, 1938, was appointed master mechanic at Avoca.

HENRY M. SHERRARD, who has been appointed master mechanic of the Baltimore & Ohio, with headquarters at Grafton, W. Va., as noted in the March issue of the *Railway Mechanical Engineer,* was born on April 28, 1888. He attended grade and high schools and entered railroad service on March 3, 1903, as a messenger in the office of the superintendent of motive power office of the B. & O. In April of the same year, Mr. Sherrard became a machinist apprentice. From 1907 to 1915 he was a machinist at Newark, Ohio. He was piece work inspector at Newark for a period of one year, and in 1916 became assistant machine shop foreman. In 1918 he became machine shop and general foreman and in 1925 was transferred to Glenwood (Pittsburgh), Pa., as general machine shop foreman. In May, 1930, he became motive power inspector of the Western Lines and on December 21, 1937, was appointed master mechanic at Grafton.



Henry M. Sherrard

Car Department

THOMAS BELL has been appointed acting night car foreman at the Ocean Terminals (Halifax, N. S.) of the Canadian National.

JOSEPH E. HARLEN, night car foreman of the Canadian National at the Ocean Terminals, Halifax, N. S., has been appointed acting day car foreman.

P. H. MITCHELL, who has been appointed master car builder of the Delaware, Lackawanna & Western at Scranton, Pa., succeeding E. M. Jenkins, retired, was born at Prescott, Ark. He entered railroad service as a car repairman with the Prescott & North-western and subsequently was employed as a car foreman on the Memphis, Dallas & Gulf (now part of the Graysonia, Nashville & Ashdown and the Murfreesboro-Nashville) at Nashville, Ark. Leaving that company Mr. Mitchell entered the employ of the San Antonio, Uvalde & Gulf as air brake inspector and steam heat supervisor, later returning to the Memphis, Dallas & Gulf as master car builder. He was general car inspector of the Texas & Pacific, at Dallas, Tex., prior to entering the service of the Delaware, Lackawanna & Western two years ago, and until his appointment as master car builder, had been general car inspector at Scranton.



P. H. Mitchell

W. A. EMERSON, master car builder on the Elgin, Joliet & Eastern at Joliet, Ill., has been promoted to the newly created position of general master car builder, with jurisdiction extended to cover the Gary division, and with headquarters as before at Joliet. The office of master car builder at Joliet is abolished.

A. A. BURKHARD, superintendent of shops of the Merchants Despatch Transportation Corporation, at East Rochester, N. Y., who has retired from active service, as noted in the May issue, began his career in the car department of the Pittsburgh & Lake Erie at Pittsburgh, Pa., in April, 1884, as a messenger and office boy. He later served consecutively as car builder apprentice in the shops at McKees Rocks, Pa., then in various departments of the shops, as mechanic and inspector and as division general foreman at Glass-

(Continued on next left-hand page)

"Utilization and Availability of Locomotives"

"The longer freight-locomotive run is ofttimes interfered with by lack of fuel and water capacity . . ."

Extract of Paper

by W. H. FLYNN, Gen'l. S. M. P. & R. S., N. Y. Central System, presented before Fuel and Traveling Engineers Association, September, 1937.

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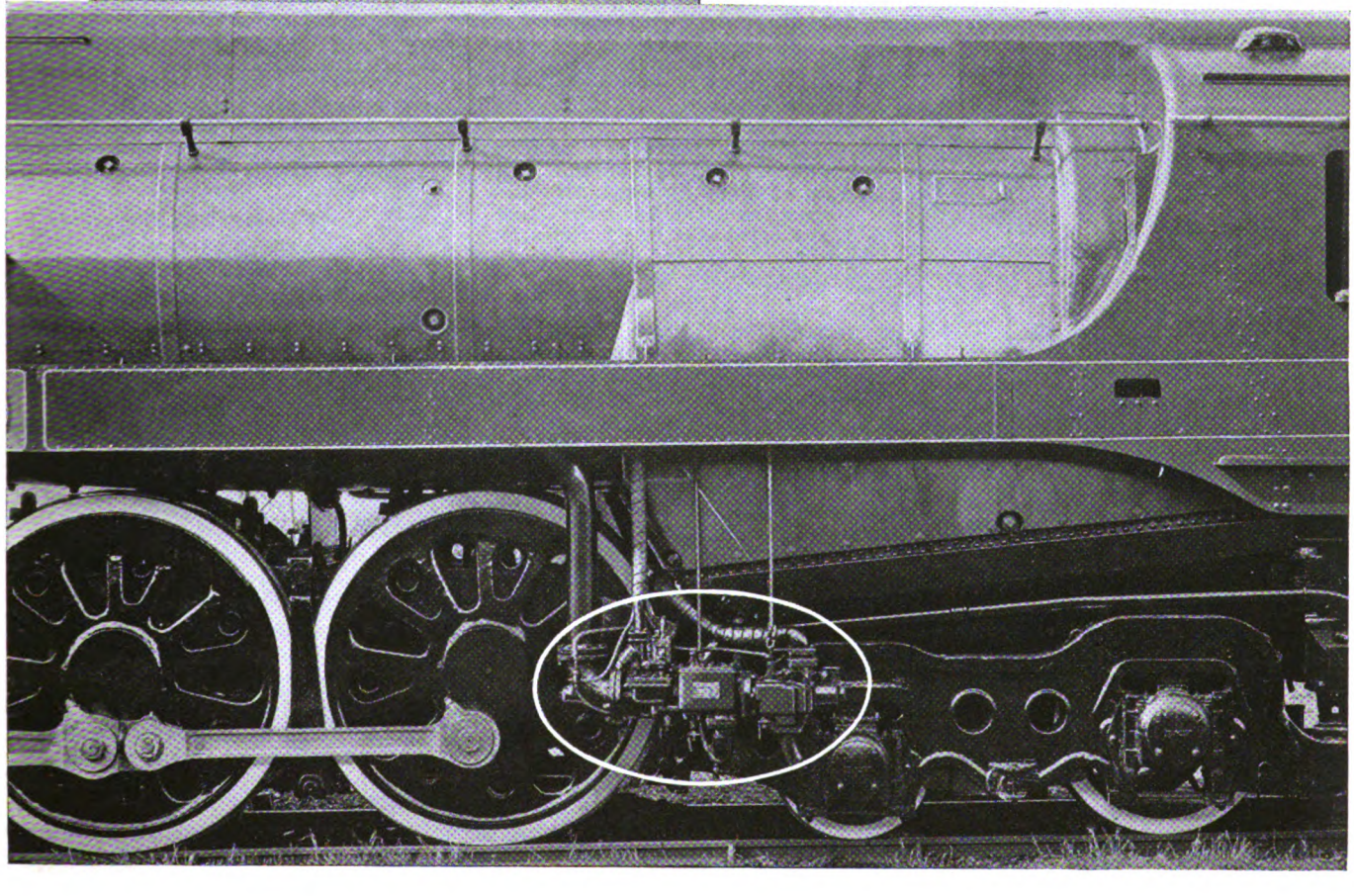
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port, Pa. In 1908 he was transferred to the West Albany, N. Y., shops of the New York Central as assistant general foreman; in February, 1916, he was promoted to general foreman, and in May, 1920 became division general foreman. Mr. Burkhard was transferred to Selkirk, N. Y., in March, 1925, and in August, 1930, went to the East Rochester shops of Merchants Despatch as superintendent of shops.

Obituary

GEORGE W. BEBOUT, electrical and shop engineer on the Chesapeake & Ohio died on May 10. Born at Parkersburg, W. Va., on May 18, 1874, Mr. Bebout received his



George W. Bebout

secondary education at the Greenbrier Seminary and, subsequently, the Allegheny Collegiate Institute, where he specialized in electrical engineering and power plants. In 1894 he entered the service of the Richmond Railway & Electric Company, where he served for four years in various capacities. Following this, he was employed by the Chesapeake & Ohio in shop service for a few months, after which he went with the Richmond Locomotive Works (now the American Locomotive Works). Here, he was promoted from foreman of the electrical department to electrical engineer of the American Locomotive Company, to succeed E. M. Archibald. Later Mr. Bebout also took over the duties of shop engineer as well, with the title of electrical and shop engineer, serving in this capacity until 1912, when he entered the service of the Chesapeake & Ohio, in the capacity which he held at the time of his death. He was president of the Association of Railway Electrical Engineers, 1932-33.

JOHN J. CONN, general purchasing agent for the Atchison, Topeka & Santa Fe, with headquarters in Chicago, died at his home in Oak Park, Ill., on April 28.

WILLIAM A. MCCAFFERTY, master mechanic in charge of the Columbus, Ga., shops of the Central of Georgia, died suddenly at his home in that city on April 21, following a heart attack.

GEORGE E. SMART, who retired in June, 1932, as chief of car equipment of the Canadian National, died on April 25, at his home in Montreal, Que. Mr. Smart was born in Edinburgh, Scotland, on December 23, 1873, and began railroad service in 1892, in the car department of the Grand Trunk. He was with the Canadian Pacific from 1904 to 1913, holding successively the positions of general inspector, heating and lighting; general car inspector, and divisional car foreman, Eastern lines. In 1913 he became master car builder of the Canadian Government Railways (now C. N. R.), at Moncton, N. B., and in 1918



George E. Smart

was sent to Toronto, Ont., as general master car builder of the Canadian National. In 1920 Mr. Smart's jurisdiction was extended to include the Grand Trunk Pacific lines and later in the same year he became mechanical assistant to the operating vice-president. In 1923 he was appointed chief of car equipment, with headquarters at Montreal. Mr. Smart served as vice-chairman of the Mechanical Division, American Railway Association, from 1926 to 1927, and as chairman from 1928 to 1930.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

"DYN-EL."—Alan Wood Steel Company, Conshohocken, Pa. 46-page, paper-bound booklet descriptive of Dyn-el, a new high-strength flat-rolled steel with unusual resistance to fatigue, impact and corrosion. Tables and diagrams.

◆

LATHES.—The R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Bulletin No. 11-19 R. P., "Doubling Production per Hour," 438. Describes heavy-duty, rapid-production lathes and illustrates a number of forms of tool set-ups.

◆

METALSPRAY.—Bulletin 800, issued by the Metalspray Company, Incorporated, 113 Llewellyn street, Los Angeles, Calif., briefly describes some new applications of Metalspray, a method of spraying molten metal on all materials. Copper is used in the printing of this circular as pertinent to the subject matter.

◆

MONEL GASKETS, PUMP PARTS, VALVE TRIM.—The International Nickel Company, Inc., 67 Wall street, New York. Six-page bulletin. Applications of Monel rods and cylinder liners, Monel plungers in high-pressure pumps, Monel valves, etc.

STEAM DROP HAMMERS.—Erie Foundry Co., Erie, Pa. Bulletin No. 325; 23 pages. Pictorial description of the design, construction and operation of the Erie steam drop hammers.

◆

ARC WELDERS.—General Electric Co., Schenectady, N. Y. Booklets GEA-144OG and GEA-175OD. Type WD single-operator arc welders and Type WK a.c. welders, respectively.

◆

RAIL WELDING.—Metal & Thermit Corporation, 120 Broadway, New York. Pamphlet 117, "Continuous Rail for Main Line Track." 30 pages. Describes the history of rail welding throughout the U. S. and Europe and illustrates installations on the D. & H. at Schenectady, N. Y.; the B. & L. E. at River Valley, Pa., and the Northern Pacific at Elliston, Mont., and Livingston.

WROUGHT STEEL WHEELS.—American Iron and Steel Institute, 350 Fifth avenue, New York. Steel Products Manual, Section 20; 14 pages. Describes briefly forging and rolling of wrought steel wheels for steam- and electric-railway service and for industrial purposes, and defines technical terms relating to their heat treatment and machine finishing.

◆

RAILWAY AIR CONDITION EQUIPMENT.—The Trane Company, La Crosse, Wis. Bulletin V258. Contains a 28-page exposition of the Trane system of electro-mechanical air conditioning, primarily for car installations; descriptions of convectors used in house heating and of multiple-type projection heaters, and a general catalog of Trane products.

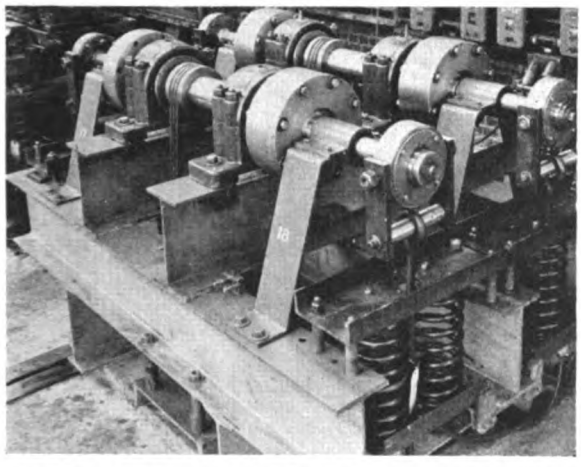
◆

JOURNAL BEARINGS FOR RAILROAD SERVICE.—SKF Industries, Inc., Front street and Erie avenue, Philadelphia, Pa. 40 pages. A description of SKF spherical roller bearings and a photographic history of the more important installations in the United States and Canada on car and locomotive journals of both steam and electric types.

RAILWAY MECHANICAL ENGINEER

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.



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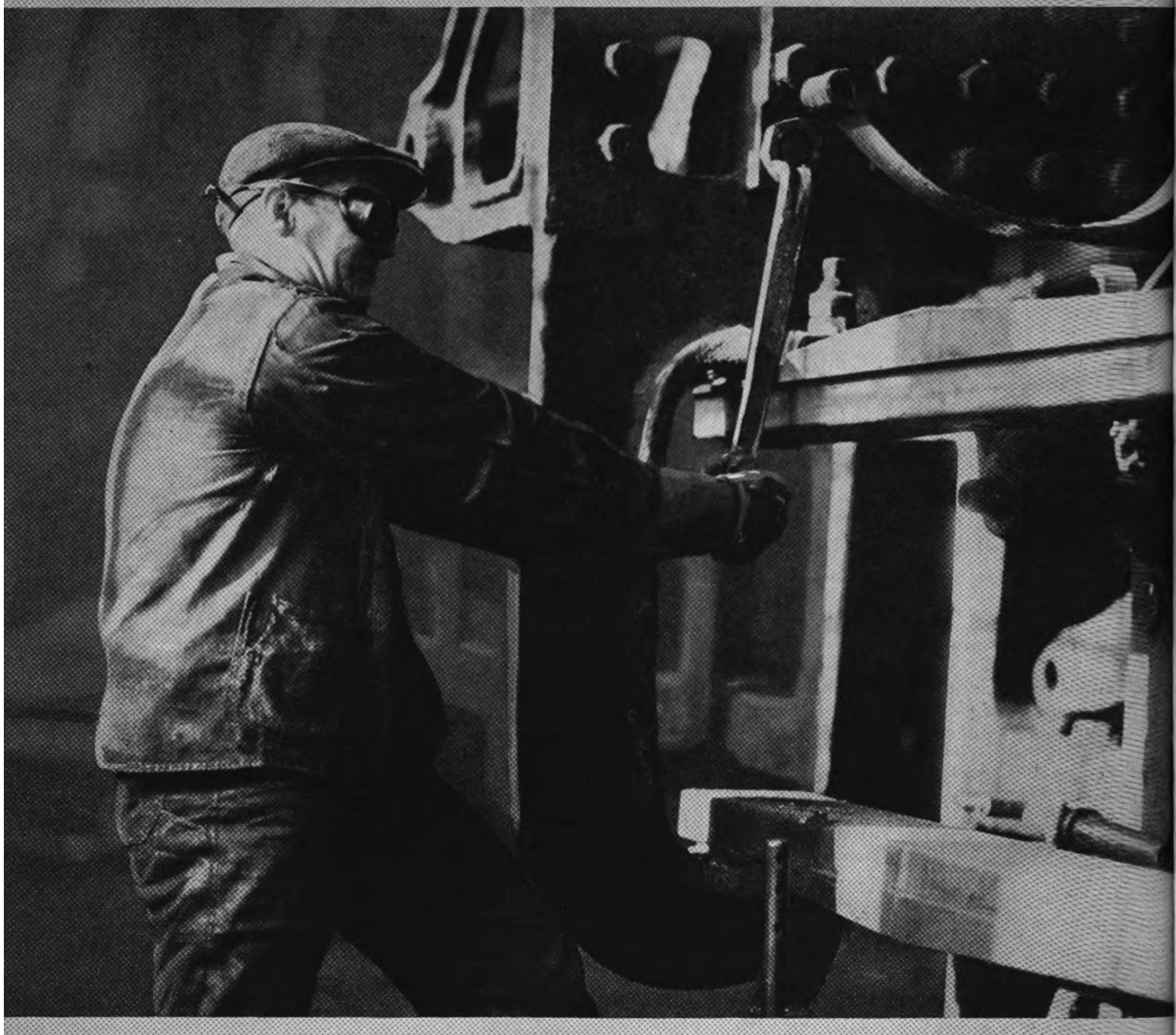
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STRETCHING STARTS TROUBLE



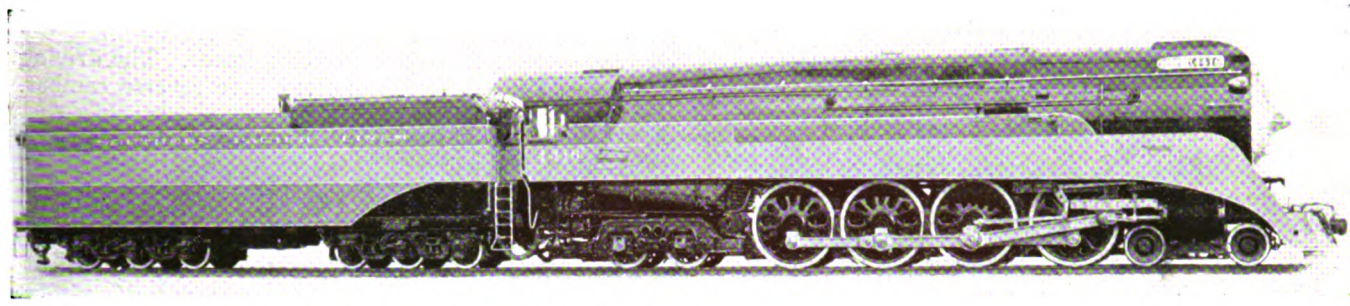
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High-speed heavy passenger locomotive built by Lima for the Southern Pacific

Southern Pacific Receives Second Lot of

Streamline 4-8-4 Locomotives

Fourteen locomotives designed for fast passenger-train service were built by Lima—Each locomotive develops a total tractive force of 75,000 lb.

THE Lima Locomotive Works, Inc., recently delivered to the Southern Pacific fourteen 4-8-4 high-capacity streamline passenger locomotives which are similar in general design and streamlining to six 4-8-4 locomotives* built early last year specifically for handling the Daylight train service inaugurated about a year ago between San Francisco and Los Angeles. However, the new locomotives, with 80-in. driving wheels and developing a total maximum tractive force of 75,000 lb. are somewhat greater in capacity and designed for higher speeds than the first six built, which have 73½-in. driving wheels and develop a total tractive force of 74,710 lb.

The principal differences in the two lots of locomotives lie in the greater length of the wheel base and boiler of the later locomotives. The increased boiler pressure and the changes in the diameter and stroke of the cylinders. There have also been some changes in details, notably in the lightening of the reciprocating parts and in the boiler material.

The later locomotives have a driving-wheel base of 21 ft. 6 in. and a total engine wheel base of 47 ft. 8 in. The driving-wheel base of the first locomotives is 18 in. shorter and the total engine wheel base 22 in. shorter. The weight on the drivers has been increased only about 800 lb. The total weight of the locomotive, however, is 11,600 lb. greater. The boiler pressure of the later locomotive was increased 30 lb. to 280 lb. per sq. in. and the cylinders have been decreased 1 in. in diameter to 26 in., but increased in stroke from 30 to 32 in. Thus, the locomotives develop a cylinder tractive force of 62,800 lb., an increase of 600 lb. over the earlier lot.

The Boiler

The boiler of the later locomotive is practically identical in dimensions with that of the earlier lot, with the exception of an increase of 20 in. in the length of the combustion chamber. The barrel of the boiler is in three courses, the middle one being conical in form. The dome is mounted on this course. The boiler shell and roof sheet are of nickel steel, whereas basic openhearth steel was used in the construction of the earlier lot. This affords an interesting comparison of the effect of the two materials on the weight of the locomotives. The nickel-steel in the later boiler, designed to carry a working pressure of 280 lb., is ⅞ in. thick in the first ring, $^{15}/_{16}$ in. thick in the conical ring, and $^{31}/_{32}$ in. thick in the third ring. The carbon steel in the earlier locomotives, designed for a working pressure of 250 lb. per sq. in., is $^{1}/_{16}$ in. more in thickness in the first and second rings and $^{3}/_{32}$ in. more in thickness in the third ring, the outside diameters of the first and third rings, respectively, being identical in the two boilers.

The firebox is fitted for oil burning and includes a combustion chamber which extends 80 in. into the barrel of the boiler. Welding was used extensively in the firebox construction. The crown sheet is butt welded to the side sheets and combustion chamber and the throat connection is butt welded to the crown, sides and combustion chamber. The door flanges in the back head and inside door sheet are also butt welded. Both the inside door sheet and the tube sheet are riveted in place. Seal welding has been employed on calking edges at a number of points in the firebox and at the mud-ring corners.

There is a complete installation of Flannery flexible staybolts around the combustion chamber, except for the long radial stays over the top. Flexible stays are also installed along the top of the sides and diagonally across the front and back top corners of the firebox in the breaking zone; also, there is a complete installation of flexible stays in the throat, and in breaking zone in the back head.

The boiler is equipped with a Type E superheater and

* Described in the March, 1937, issue of the *Railway Mechanical Engineer*, page 102.

Tangential dryer. The feedwater heater is the Worthington No. 5SA.

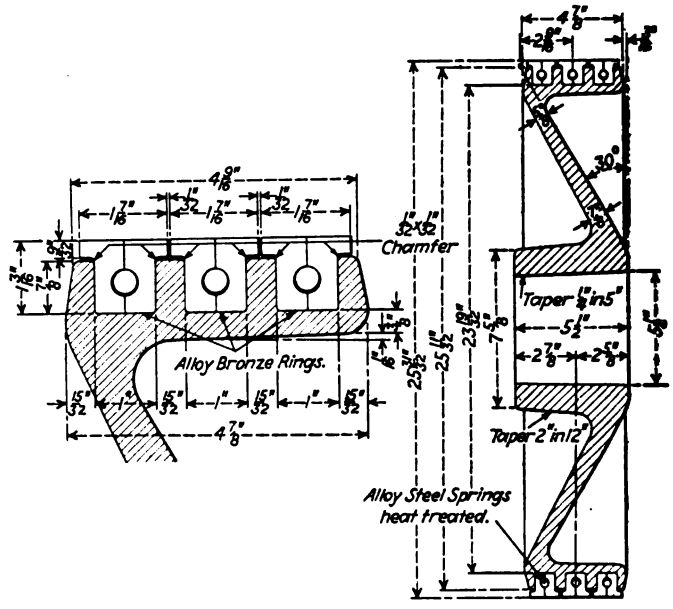
Foundation and Running Gear

Like their predecessors, the foundation of these locomotives is the General Steel Castings bed with which the cylinders and front bumper are cast integral. The back cylinder heads, however, are separate castings. Both trucks, also of General Steel Castings Company design, are fitted with oil-packed journal boxes. Owing to an increase of almost 6,000 lb. in weight carried by the engine truck, the journals have been increased from 7 in. by 14 in. on the earlier order to 7½ in. by 14 in. No changes were required in the trailer truck.

The driving axles are all fitted with grease-packed cellars and the wheels are of the Boxpok type. All of the axles under the locomotives are of medium carbon steel, normalized and drawn. The Alco lateral cushioning device is applied on the front driving boxes. The driving springs of the newer locomotives have reverse camber.

General Dimensions, Weights and Proportions of Two Lots of Southern Pacific 4-8-4 Type Locomotives

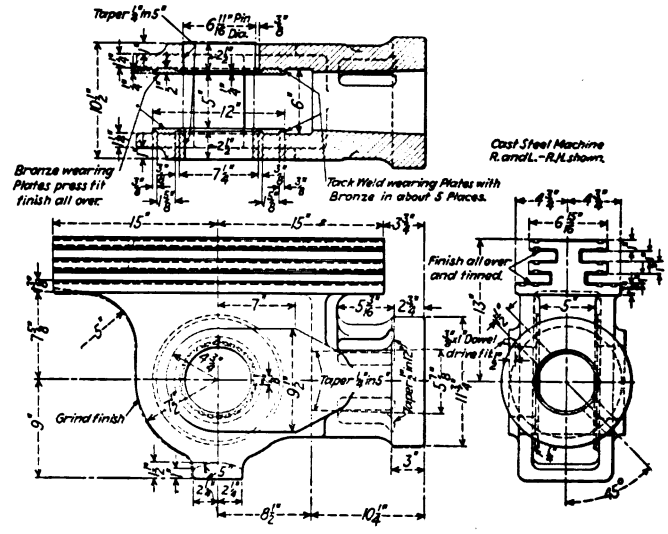
	Built early in 1937	Built late in 1937
Railroad	Sou. Pac.	Sou. Pac.
Builder	Lima	Lima
Type of locomotive	4-8-4	4-8-4
Road class	S448	S460
Road numbers	4410	4416–4429
Service	Pass.	Pass.
Dimensions:		
Height to top of stack, ft.-in.	16–4	16–4
Height to center of boiler, ft.-in.	10–8	10–8
Width overall (includ. streamline), in.	10–10	10–10
Cylinder centers, in.	93	94
Weights in working order, lb.:		
On drivers	266,500	267,300
On front truck	77,400	83,300
On trailing truck, front	46,300	49,500
On trailing truck, rear	58,200	59,900
Total engine	448,400	460,000
Tender	372,880	372,880
Wheel bases, ft.-in.:		
Driving	20–0	21–6
Rigid	13–0	14–0
Engine, total	45–10	47–8
Engine and tender, total	94–1½	95–10½
Wheels, diameter outside tires, in.:		
Driving	73½	80
Front truck	36	36
Trailing truck	45½	45½
Engine:		
Cylinders, number, diameter and stroke, in.	27 x 30	26 x 32
Valve gear, type	Walschaert	Walschaert
Valves, piston type, size, in.	12	12
Maximum travel, in.	7¼	7¼
Steam lap, in.	1¾	1¾
Exhaust clearance, in.	5/16	5/16
Lead, in.	¼	¼
Cutoff in full gear, per cent	73½	73½
Boiler:		
Type	Conical conn.	Conical conn.
Steam pressure, lb. per sq. in.	250	280
Diameter, first ring, outside, in.	86	86
Diameter, largest, outside, in.	96	96
Firebox, length, in.	127⅛	127⅛
Firebox, width, in.	102¼	102¼
Combustion chamber length, in.	60	80
Tubes, number and diameter, in.	49–2¼	49–2¼
Flues, number and diameter, in.	198–3½	198–3½
Length over tube sheets, ft.-in.	21–6	21–6
Fuel	Oil	Oil
Grate area, sq. ft.	90.4	90.4
Heating surfaces, sq. ft.:		
Firebox and comb. chamber	350	385
Tubes and flues	4,502	4,502
Evaporative, total	4,852	4,887
Superheating	2,086	2,086
Combined evap. and superheat	6,938	6,973
Tender:		
Style	Rectangular water bottom	Rectangular water bottom
Water capacity, gal.	22,000	22,000
Fuel capacity, gal.	6,010	6,010
Trucks	6-wheel	6-wheel
Journals, diameter and length, in.	7 x 14	7 x 14
General data, estimated:		
Rated tractive force, engine, lb.	62,200	62,800
Rated tractive force, booster, lb.	12,510	12,200
Total rated tractive force, lb.	74,710	75,000
Weight proportions:		
Weight on drivers ÷ weight engine, per cent	59.2	56.8
Weight on drivers ÷ tractive force	4.28	3.56
Weight of engine ÷ evaporation	92.43	94.14
Weight of engine ÷ comb. heating surface	64.63	65.98
Boiler proportions:		
Firebox heat. surface, per cent comb. heat. surface	5.04	5.53
Tube-flue heat. surface, per cent comb. heat. surface	64.9	64.6
Superheat. surface, per cent comb. heat. surface	30.06	29.91
Tube-flue heat. surface ÷ grate area	49.8	49.8
Firebox heat. surface ÷ grate area	3.87	4.26
Superheat. surface ÷ grate area	23.08	23.08
Comb. heat. surface ÷ grate area	76.75	77.12
Evaporation ÷ grate area	53.66	54.05
Tractive force ÷ grate area	688.05	829.6
Tractive force ÷ evaporation	15.40	15.35
Tractive force ÷ comb. heat. surface	8.97	10.76
Tractive force x dia. drivers ÷ comb. heat. surface	658.94	860.6



Made of electric cast steel, the pistons have thin walls and reduced hub diameter

A considerable reduction in the weight of reciprocating parts has been effected in the design of the later locomotives. Both locomotives are fitted with the multiledge guide and crossheads. On the later locomotives, however, the body of the crosshead has been reduced in size and strengthened by increasing the section connecting the piston-rod hub with the wrist-pin bosses. The pistons were furnished by the Locomotive Finished Material Company and are of electric cast-steel with thin

(*Continued on page 274*)



The crossheads of the new S. P. 4-8-4 locomotives have been reduced in size and strengthened by increasing certain section thicknesses

General Committee Acts on

Mechanical Division Reports



J. W. Burnett, Chairman



F. W. Hankins, Chairman-elect

The reports presented by the chairmen of twelve committees show that much constructive work has been done despite the adverse conditions prevailing during much of the past year — Standardization work proceeding on details of locomotive construction as well as in car designs

BECAUSE of the prevailing general business conditions, no annual meeting of the Mechanical Division of the Association of American Railroads was held this year. That the work of the Division might be carried forward with as little interruption and delay as possible, the General Committee held a meeting on June 29 at the Congress Hotel, Chicago, at which committee chairmen and chairmen of the important sub-committees were in attendance to present their reports, of which there were twelve, on the following subjects. Prices, Tank Cars, Loading Rules, Wheels, Brakes and Brake Equipment, Locomotive Construction, Arbitration, Couplers and Draft Gears, Underwriter's Laboratory Tests, Car Construction, Specifications, and Further Development of the Reciprocating Steam Locomotive.

The report on the Underwriter's Laboratory Tentative Outline for Inspection and Labeling of Self-Propelled Railroad Equipment Utilizing Internal Combustion Engines is a new one this year. The regulations submitted for the safe handling of liquefied petroleum gas promise to promote safety in the use of this fuel, now in growing demand for internal-combustion engines, coach lighting, heating in refrigerator cars, cooking in diners, etc., if they are adopted by the association.

Among the new subjects in the standing committee reports is the standard refrigerator car, for which the committee has developed a complete set of general specifications covering materials, workmanship, and the character of the major details of construction. The committee recommends holding in abeyance the development of complete standard designs pending the outcome of studies now under way to effect freight-car weight reduction.

During the course of the meeting the General Committee also listened to two progress reports, one on the passenger-car axle tests being conducted at the Timken research laboratory and one on failures of locomotive driving axles and crank pins, which were presented by W. I. Cantley, mechanical engineer of the Mechanical Division. These reports will be the subjects of articles which will appear in later issues.



W. H. Flynn, Vice-chairman-elect



V. R. Hawthorne, Secretary

For the first time new officers and members of the General Committee, to succeed those whose terms expire this year, have been elected by letter ballot rather than by ballot of the members in attendance at an annual meeting. Without exception, the retiring members of the board were re-elected. J. W. Burnett (general superintendent motive power and machinery, Union Pacific), the retiring chairman, was elected to serve for the unexpired term of W. H. Flynn, the vice-chairman elect. The officers and re-elected members of the General Committee are as follows: Chairman, F. W. Hankins, chief of motive power, Pennsylvania System; vice-chairman, W. H. Flynn, general superintendent motive power and rolling stock, New York Central System. General Committee: D. S. Ellis, chief mechanical officer, Chesapeake & Ohio; O. A. Garber, chief mechanical officer, Missouri Pacific; R. G. Henley, superintendent motive power, Norfolk & Western; F. R. Mays, general superintendent equipment, Illinois Central; John Purcell,

assistant to vice-president, Atchison, Topeka & Santa Fe; A. L. Ralston, general mechanical superintendent, New York, New Haven & Hartford, and Mr. Burnett.

Locomotive Construction

Exhaust Steam Injectors

During the year 1937, 59 locomotives were equipped with exhaust steam injectors and 25 locomotives on order for 1938 are also to be equipped. The steam pressures carried, or to be carried, by these locomotives ranged from 205 lb. to 300 lb. Fourteen of the locomotives being built during 1937 were equipped with turbo injectors. Twenty-two of the locomotives built during the year 1936 were equipped with exhaust-steam injectors, five of which were turbo injectors.

Advantages and Disadvantages of Higher Boiler Pressures

There has not been a sufficient number of locomotives in service with pressures above 300 lb. per sq. in. a long enough time to develop their full operating efficiency and to get comparative cost of their maintenance expense. This is particularly true at present because of the reduced business being done by the railroads with less locomotive miles being made, and no additional information is available from the various roads over that contained in last year's report. However, the fact that additional locomotives are being built at the present time with over 300 lb. boiler pressure indicates the trend is still upward as regards this feature.

The boiler should be as large as possible so as to have available the necessary reserve capacity to keep the heavy tonnage trains moving at the prescribed speed under all conditions.

One important thing necessary to obtain the full benefit of high pressure is a steam distribution valve which can be made to cut off at a low percentage of the stroke, and some progress is being made in this direction now by the use of the double-ported valve, also the poppet valve, though much remains to be accomplished with the latter.

The committee recommends that this be accepted as a progress report and the committee continued, to report again next year.

[The sub-committee appended a tabular comparison of dimension and ratios of several high-pressure locomotives. These include two 2-10-4 locomotives; one for the A. T. & S. F. built in 1930 and one for the K. C. S. built in 1937; two 4-8-4 locomotives, both built in 1937, one for the Union Pacific, and one for the A. T. & S. F.; and three 4-6-4 locomotives, one for the B. & O., built in 1936, one for the A. T. & S. F., built in 1937, and one for the C. & N. W., built in 1938. With two exceptions, all of these locomotives carry a boiler pressure of 300 lb. The K. C. S. 2-10-4 locomotive carries 310 lb. and the B. & O. 4-6-4 locomotive carries 350 lb.—Editor.]

Development and Use of Oil-Electric Locomotives

Your committee has continued investigations of principal developments and has analyzed available data and statements submitted showing the number of Diesel locomotives in service in the United States and Canada, including new installations for the year 1937 and those units on order as of March 1, 1938. The information has been assembled through the assistance and records of various manufacturers as well as operating companies.

This study indicates that in 1937 a total of 155 locomotive units were placed in service. There was greater progress in the development and installation of new units of Diesel equipment than in any previous year. During this same period there were three 3,600-hp. and two 5,400-hp. units placed in service. The 5,400-hp. units are the first of this capacity and, prior to 1937, there was only one 3,600-hp. unit in service. There are on order, as of March 1, 1938, four additional 3,600-hp. units. The trend towards larger capacities is indicated by six 1,800-hp. units on order as of March 1, 1938. Units of 600 hp. capacity still seem to predominate the field for switching locomotives, 87 locomotives of this capacity being installed during 1937, with 30 additional on order as of March 1, 1938. The next greatest demand was for 900-hp. units, 42 of which were installed during 1937, with 7 more on order as of March 1, 1938.

It is also noted that there were seven installations of Diesel

Assignment of Diesel Locomotives in Service as of December 31, 1937, by Class of Service

Hp. Less than	Switch.	Transfer	Road freight	Road passenger	Grand total
300	13	..	..	..	13
300	96[1]	1	..	..	97
310	1	..	..	..	1
400	6	.	..	..	6
460	3	..	..	..	3
500	..	1	..	..	1
530	7[2]	..	..	..	7
550	1	..	..	..	1
600	168[3]	1	1	1	171
660	5	..	..	..	5
750	..	.	1	..	1
800	6[3]	..	..	1	7
900	43	..	..	..	43
950	..	..	..	1	1
1,000	4	..	..	..	4
1,200	..	..	..	6	6
1,330	..	..	..	2[4]	2
1,600	1	..	..	..	1
1,800	..	2	..	3	5
2,000	..	1	..	..	1
2,100	..	..	..	1	1
2,400	..	..	..	4	4
3,000	..	..	..	2	2
3,600	..	..	..	4	4
5,400	..	..	..	2	2
Total	354	6	2	27	389

[1] 38 units used in combination switch and transfer of passenger equipment.
[2] One unit in combination switch and road freight service.
[3] Two 600-hp. and three 800-hp. units used in combination switch and transfer service.
[4] Used single in passenger service and in combination with freight service.

Operating Statistics and Maintenance Cost of Diesel Locomotives

Exhibit No. 1

Name of Operating Company _____ Unit Number or Identification _____

Class of Service _____ Horsepower _____

Month or Calender Year	Miles or hours Assigned and Operated			Lubricating Oil		Fuel Oil		Repairs					Cost of Repairs per Hour or Mile
								Electrical Equipment		Diesel			
	Assigned	Operated	Per Cent of Assignment Operated	Gallons Used	Gallons Per Hour or Mile	Gallons Used	Gallons Per Hour or Mile	Labor	Material	Labor	Material	Total	

Report on basis of cost or amount per hour for engines in switch and transfer service

Report on basis of cost or amount per mile for engines in road freight or road passenger service

Form for collecting Diesel-locomotive operating and maintenance statistics recommended by the committee

locomotives with less than 300 hp. during the year, while prior to 1937 there had only been six such installations, which indicates that this type of equipment is being adapted to more general service and this helps to account for the fact that of the 389 units in service as of January 1, 1938, 155 or 40 per cent were placed in service during the year 1937.

The table shows the assignment of Diesel locomotives by class of service and the preponderance of these units still remains in switching service, with the addition of 143 units to the 210 so reported in 1936, although many of the units of 600 hp. and greater are reported as used in combination switch and transfer service. There has been a marked increase in the number of Diesel engines used in road passenger service. Units so reported were increased to 27 from 16, an increase of 69 per cent.

Attempt has been made to compile comparative operating statistics designed to indicate the availability of these units, lubricating and fuel oil consumption and cost of repairs, separated between electrical equipment and Diesel equipment, and the total cost of repairs per locomotive hour operated, and while the committee hopes to be able to assemble some interesting information along the above lines for future reference and comparison with cost of maintenance and fuel and lubrication costs for steam locomotives, to date this has not been completed.

It is the recommendation of the committee that the association adopt a uniform report from which such information can be readily assembled and this report should be so arranged as to permit the entry of each month's figures together with the cumlative for previous months of the year, and finally, the total figures for the full year.

Design of Fundamental Parts of Locomotives

The sub-committee dealing with the design of fundamental parts of locomotives reported on three subjects.

Driving-Wheel Centers with Thin Wall Sections

This year the committee discontinued the statement giving details of the application of the various types of driving-wheel centers with thin wall sections, since they are now being used almost universally. The answers to a questionnaire, to which ten roads replied, indicates that only three centers, on two roads, were rejected because of defects showing up when new centers were machined, but that all except three of the roads have experienced some cracking of the castings after periods of service, usually, but not always, between the crank-pin and axle hubs. Some of these wheels were of early designs which have later been improved. Some were put back in service after welding; others were replaced by new castings.

The American Locomotive Company reports rejections of the thin-wall-type wheel centers amounting to 10½ per cent, March, 1937, to March, 1938, and rejections of 20 per cent of the spoke-type wheel centers used during the same period. Baldwin reports shrinkage cavities in the ribs separating counterbalance pockets in open-face counterbalances, and the development of cracks in the hubs and counterbalance walls (not the open-face type) of some wheels after a year's service.

Only two of the roads replying report the new wheel centers out of round after service. The other roads report no occasion to true up centers, and most of them report no tests to determine roundness. The Missouri Pacific reported one main wheel from a 2-10-2 type locomotive which checked 1/32 in. out of round after two years' service. The Chesapeake & Ohio reported a maximum out-of-roundness of 1/8 in. on several wheels checked after service. Several wheels on this road of an early design, since changed by the manufacturer, were found to be dished out as much as 1/4 in. after service.

The Chicago & North Western, with service up to 300,000 miles, finds the wheels satisfactory and much less dishing of these centers due to tire-shrinkage pressure. The Missouri Pacific and the Illinois Central both comment on the better counterbalance obtainable. The Missouri Pacific was able to increase the speed of 14 2-10-2 type locomotives from 35 m.p.h. to 55 m.p.h. without track damage after the new type centers were applied on the main axles.

Furnace or Firebox Support and Waist Sheets

The General Steel Castings Corporation is making some tests on a locomotive bed of a 4-8-4 type locomotive now being built by the Baldwin Locomotive Works. These tests are to be made in such a manner as to determine, if possible, the value of waist sheets between boiler and engine bed at various points and under different conditions of service as well as when locomotives are lifted in the erecting shop. A copy of the report on the tests will be furnished to the committee when they have all been completed.

Typical Methods of Lubricating Main and Side Rods

In response to a request for such information, the sub-committee submitted drawings of several arrangements of grease cavities, with pressure fittings, in main-rod back ends and in crank pins which have been used successfully on locomotives built in recent years. These are for inclusion in the Manual.

Screw Threads

The A. A. R. standard for screw threads is the U. S. Standard, and is described and illustrated on page L-27 of the Manual, no provision being made, however, for different classes of fits or tolerances.

The American Standards Association has approved and issued an American Standard for screw threads which is identical with the A. A. R. standard in form of thread, but provides for four classes of fit to suit various requirements. It is, therefore, recommended that page L-27 of the Manual be revised by the addition of a paragraph reading as follows: "When necessary or desirable to specify a particular class of fit, reference should be made to American Standards Association Standard for Screw Threads B 1.1-1935."

Roller Bearings for Locomotives and Tenders

This report covers steam and electric locomotives, but does not include Diesel-electric or high-speed streamline trains. Replies to questionnaire were received from 126 roads, 91 of which reported having no roller-bearing applications and 35 roads reported on applications. During the year ended December 1, 1937, new applications of roller bearings were made as follows:

	Existing road locomotives	New road locomotives	Total road locomotives
Engine truck	34	67	101
Drivers	6	52	58
Trailer truck	3	42	45
Tender truck	10	27	37
Total road locomotives built during 1937			325

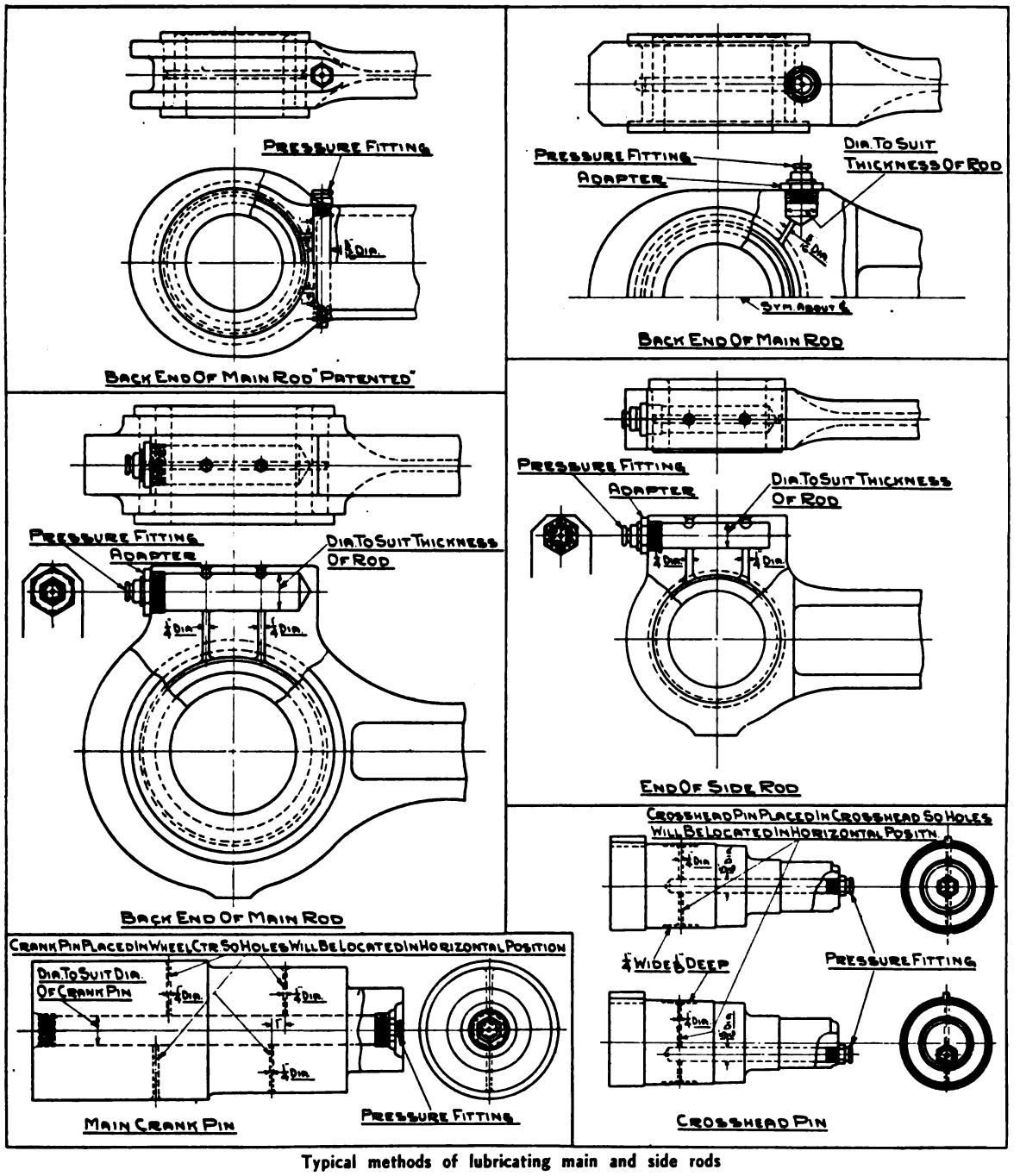
From the reports as of December 1, 1937, the following number of locomotives and tenders are in service with roller bearings:

On	No. locomotives
Engine truck	689
Drivers	280
Trailer truck	149
Tender trucks	578

Failures of roller bearings on drivers and on engine, trailer and tender trucks were comparatively few and resulted mainly from broken or worn retaining cages, broken or loose sleeves, shelled races and rollers, and broken races and rollers. Roller bearings which have failed are being replaced, in some cases, with bearings in kind and, in others, heavier cages or bearings with heavier rollers are being applied.

One Road's Experience with Roller Bearings

Engine Truck Axles	
Total number of locomotives equipped	257
Total locomotive mileage	142,260,810
Average locomotive mileage per road failure	28,452,162
Average locomotive mileage per defective bearing found by inspection	764,843
Average locomotive mileage per failed and defective bearing	744,821
Average mileage of failed and defective bearing (on bearings when mileage is known)	286,513
Road failure per 50,000 miles	.001757
Tender Axles	
Number of tenders equipped	209
Total tender mileage, Dec. 1, 1936, to June 1, 1937	11,130,887
Average tender miles per road failure	.....
Average tender miles per failed and defective bearing	1,391,361
Average miles of failed bearings	.....
Average miles of defective bearings	89,954
Average miles of failed and defective bearings	89,954



Typical methods of lubricating main and side rods

The following mileages between date of application and date of failure of roller bearings are reported by some of the roads:

	Minimum	Maximum
Engine trucks	174,098	317,913
Drivers	301,678	319,675
Trailer trucks	263,000	546,974
Tender trucks	169,903	682,061

One road reported a failure of roller bearings on drivers at 17,608 miles and another road at 22,573 miles.

While a complete report of all failures cannot be made because of insufficient information submitted with the reports, the data in the table was submitted by one large user of roller bearings who has given a complete report on locomotive engine trucks and tender trucks equipped as of June 1, 1937.

While sufficient information was not received to determine the total mileage made to date by locomotives equipped with roller bearings, some of the roads reported the following maximum mileages being made without a roller-bearing failure:

Engine truck	736,682
Drivers	346,994
Trailer truck	637,848
Tender truck	345,240

No trailer-truck or tender-truck axles have failed during the year ended December 1, 1937, but one road reported removing some main driving axles for inspection after making 124,000 to 155,000 miles and detected incipient cracks at intervals around the axle just within wheel fit. Replacement axles having a slightly different chemical composition will be applied for experimental purposes. Another reported removing some engine-truck axles that had made 120,000 miles because inspection revealed hair-line cracks and lines of demarcation around the journal where the race and collar come together.

Main and Side Rods
Valve Gears

New applications of roller bearings were made to main and side rods of three locomotives during the year ended December 1, 1937. The total applications which had been made as of that date are two locomotives on the main crank pin and five locomotives on all crank pins. Grease is used on the two locomotives having main-pin-bearing applications and oil on the five having main and side-rod bearings.

Very few failures occurred during the past year and their

causes are attributed to failure of roller-bearing cages, rod slipping on the crosshead pin, and cracked crosshead. The total mileage as of December 1, 1937, by four of the locomotives was 513,808 miles.

Seventeen locomotives were equipped with roller bearings to various parts of the valve gear during the year ended December 1, 1937, making a total of 99 locomotives now in service as of that date. No failures were reported.

Your committee will continue the tabulation of roller bearing applications, also develop information relative to facilities; such as tools, etc., that are necessary for taking care of roller bearing equipment, and will also consider economics, engineering of installations, and the lubrication of roller bearings.

Size of Copper Flue Ferrules and Copper Tubing

The sub-committee prepared a questionnaire covering the present sizes of flue ferrules, to which replies were received from 35 representative railroads owning approximately 70 per cent of the total locomotive ownership of the Class I railroads in the United States and Canada. These replies were carefully tabulated and it was found that considerable differences existed with respect to size of flue ferrules used, there being a total of 251 different sizes in use.

Proposed Standards for Flue Ferrules

I. D. ferrule	O. D. ferrule	Thickness of ferrule, U. S. S. gage No.	Length of ferrule, in., for application to ½ in.-⁹⁄₁₆ in. sheet	Length of ferrule, in., for application to ¹¹⁄₁₆ in.-¾ in. sheet	For application to tube or flue as follows: Nom. size of tube or flue, in.	Swaged to diam., in.	Diam. of hole in tube sheet, in.
1.875	2.000	16	5⁄8	3⁄4	2	1.875	2
1.875	2.062	13	5⁄8	3⁄4			2 1/16
1.875	2.125	11	5⁄8	3⁄4			2 1/8
1.750	1.875	16	5⁄8	3⁄4	2	1.750	1 7⁄8
1.750	1.937	13	5⁄8	3⁄4			1 15/16
1.750	2.000	11	5⁄8	3⁄4			2
2.125	2.250	16	5⁄8	3⁄4	2¼	2.125	2¼
2.125	2.312	13	5⁄8	3⁄4			2 5/16
2.125	2.375	11	5⁄8	3⁄4			2 3⁄8
2.000	2.125	16	5⁄8	3⁄4	2¼	2.000	2 1/8
2.000	2.187	13	5⁄8	3⁄4			2 3/16
2.000	2.250	11	5⁄8	3⁄4			2¼
3.000	3.125	16	5⁄8	3⁄4	3½	3.000	3 1⁄8
3.000	3.187	13	5⁄8	3⁄4			3 3/16
3.000	3.250	11	5⁄8	3⁄4			3¼
3.125	3.250	16	5⁄8	3⁄4	3¾	3.125	3¼
3.125	3.312	13	5⁄8	3⁄4			3 5/16
3.125	3.375	11	5⁄8	3⁄4			3 3⁄8
4.500	4.625	16	5⁄8	3⁄4	5 3⁄8 and 5½	4.500	4 5⁄8
4.500	4.687	13	5⁄8	3⁄4			4 11/16
4.500	4.750	11	5⁄8	3⁄4			4 3⁄4
3.000	3.125	16	5⁄8	3⁄4	3-in. arch tube	Not swaged	3 1⁄8
3.000	3.187	13	5⁄8	3⁄4			3 3/16
3.000	3.250	11	5⁄8	3⁄4			3¼
3.500	3.625	16	5⁄8	3⁄4	3½-in. arch tube	Not swaged	3 5⁄8
3.500	3.687	13	5⁄8	3⁄4			3 11/16
3.500	3.750	11	5⁄8	3⁄4			3¾

Proposed standards were set up. These standards comprise a total of 48 different sizes of flue ferrules, there being 24 combinations of diameter and gage and two lengths for each diameter and gage.

From replies received from the representative roads to which the original questionnaire was sent, it is believed that these proposed standards can be adopted by the majority of the roads and *it is recommended that they be submitted to letter ballot.*

The subcommittee prepared a questionnaire covering the present sizes of copper tubing being used, to which replies were received from 35 representative railroads owning approximately 70 per cent of the total locomotive ownership of the Class I railroads in the United States and Canada. These replies were carefully tabulated and it was found that considerable difference existed with respect to the sizes of copper tubing used, there being a total of 152 variations in size and gage.

In consulation with the Copper and Brass Research Association proposed standards were set up. They reduce the number of variations in size and gage from 152 to 26. Some sizes of tubing now being used such as 5⁄16 in. O. D., ⅛ in. iron pipe size, 9⁄16 in. O. D., 21⁄32 in. O. D., ⅜ in. iron pipe size, 11⁄16 in. O. D., 13⁄16 in. O. D., ½ in. iron pipe size, ¾ in. and 1 in. iron pipe size have been omitted from the proposed standards. It was found that there were very few users of these particular sizes, and it is felt that one of the proposed standard sizes can be substituted without difficulty.

If these proposed standards are adopted and lived up to by the railroads, it will result in a considerable saving to the roads in the cost of copper tubing, *and it is recommended that they be submitted to letter ballot.*

Failures of Axles and Crank Pins

The subcommittee issued a questionnaire which was sent out by the Mechanical Division December 2, 1936, to 38 railroads in the United States and Canada requesting information covering the failures in service of axles and crank pins during the six-year period ended December 31, 1936. Replies to these questionnaires have been analyzed and results of this analysis are given in the progress report on failures of driving axles and crank pins on steam locomotives which has been prepared by the subcommittee and sent to the members. The committee feels that, if the members receiving copies of this progress report will analyze it very carefully, they may find therein information that will be helpful to them in reducing failures on axles and crank pins similar to those now being experienced.

The committee is continuing the studies with respect to crank pins, as the subject of driving axles is to be given consideration following completion of tests now being conducted at Timken on passenger-car axles. The analysis of the returns received to the questionnaire indicates the need for a more intensive and specific analysis of driving-axle and crank-pin failures as they occur, as many of the returns were very incomplete. Attention to this point would materially assist the work of the committee in its future study on crank-pin failures.

Proposed Standards for Copper Tubing for Railroad Service

Actual O. D., in.	For air brake, air conditioning and miscellaneous uses: Wall thickness In.	Wall thickness B. W. G. No.	Wt. per ft., lb.	Calculated bursting press., lb. per sq. in.	For lubricator oil lines and saturated steam up to 450 deg. F.: Wall thickness In.	Wall thickness B. W. G. No.	Wt. per ft., lb.	Calculated bursting press., lb. per sq. in.
¼	0.032	21	0.085	7,680	0.065	16	0.146	15,600
3⁄8	0.032	21	0.133	5,120	0.065	16	0.245	10,400
½	0.049	18	0.269	5,880	0.083	14	0.421	9,970
5⁄8	0.049	18	0.344	4,700	0.083	14	0.547	7,970
¾	0.049	18	0.418	3,920	0.095	13	0.757	7,590
7⁄8	0.065	16	0.641	4,460	0.095	13	0.901	6,520
1	....	..	....	....	0.109	12	1.183	6,540
1 1⁄8	0.065	16	0.839	3,470	....	..	....	....
1¼	....	..	....	....	0.109	12	1.514	5,230
1 3⁄8	0.065	16	1.04	3,110	....	..	....	....
1½	....	..	....	....	0.120	11	2.02	4,700
1 5⁄8	0.072	15	1.36	2,660	....	..	....	....
1¾	....	..	....	....	0.120	11	2.38	4,120
2	....	..	....	....	0.120	11	2.74	3,600
2¼	....	..	....	....	0.134	10	3.45	3,600
2½	....	..	....	....	0.134	10	3.86	3,240
2¾	....	..	....	....	0.148	9	4.69	3,230
3	....	..	....	....	0.148	9	5.14	2,960
3¼	....	..	....	....	0.165	8	6.19	3,050
3½	....	..	....	....	0.165	8	6.69	2,830

Bursting pressure is calculated from the formula p = 2 × wall thickness × tensile strength ÷ outside diameter. Tensile strength = 30,000 lb. per sq. in.

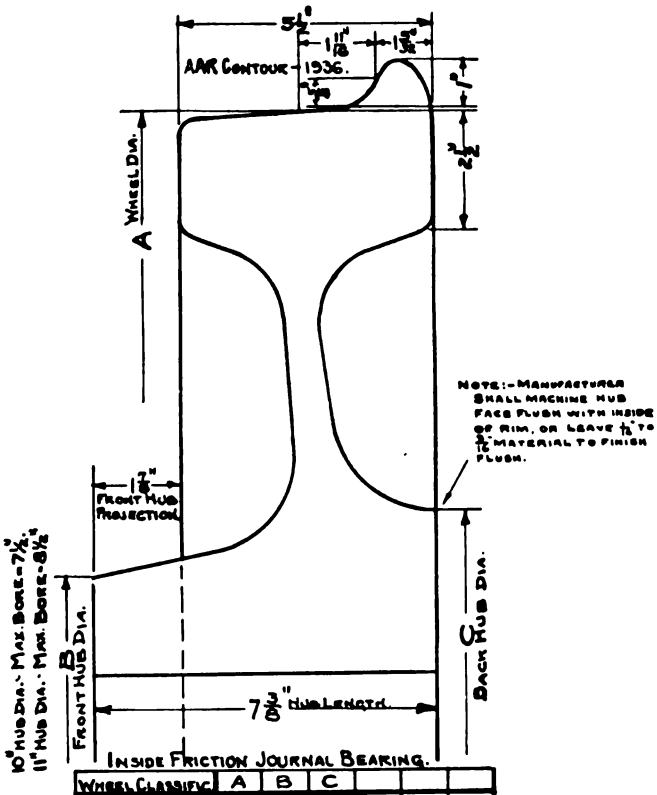
Standardization of Rolled-Steel Wheels for Engine Trucks

From the information received in answer to a questionnaire, to which 118 railroads replied, the committee developed that at the present time there are 142 designs of engine-truck wheels in use of various diameters from 26 in. to 37 in. It is felt that wheels of 30-in., 33-in. and 36-in. diameters can be proposed for new and existing locomotives. To meet the conditions on a number of existing locomotives another design of wheels of the same diameter is proposed. The latter design is not recommended for new locomotives and is to be used only until such time as the locomotives now requiring them are removed from service. The proposed designs, ten in number, will take care of approximately 93.5 per cent of the locomotives reported, either as the designs now stand, or with slight modification.

It is believed that these proposed standards can be adopted, and *it is recommended that they be submitted to letter ballot.*

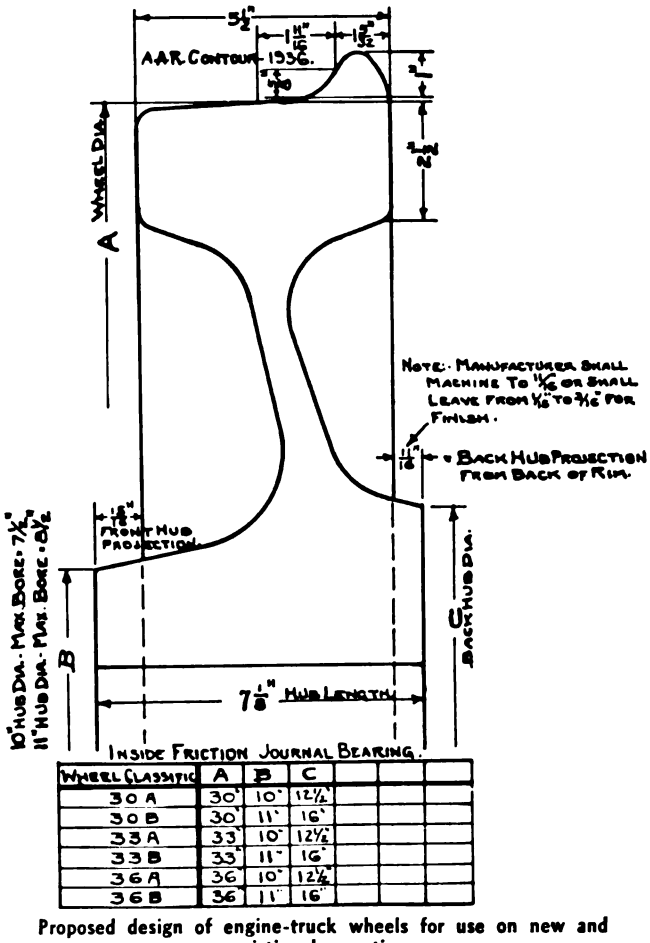
Progress Reports

The subcommittee on Standardization of Valves reported progress on the design of globe and angle valves for superheated steam up to 400 lb. pressure and 700 deg. F. temperature. Progress reports were also presented by the subcommittees investigating the shelling of trailer tires, the subcommittee on the construction of locomotive boilers by the fusion-welding process, which is keeping in touch with the service developments of the D. & H. fusion-welded boiler, and by the sub-committee investigating the question of lateral on the front wheels of four-wheel trailing trucks, spring suspension and rail stresses. A joint subcommittee of the Committee on Couplers and Draft Gears and the Committee on Locomotive Construction has been appointed to consider draft gears for the rear of the tenders of passenger locomotives with a view to the improvement of the riding of passenger cars, particularly of the lightweight type under certain conditions when hauled by steam locomotives.



Wheel Classific.	A	B	C
30 A	30"	10"	12½"
33 A	33"	10"	12½"
33 B	33"	11"	16"
36 A	36"	10"	12½"

Proposed design of engine-truck wheels for use on existing locomotives only



Wheel Classific.	A	B	C
30 A	30"	10"	12½"
30 B	30"	11"	16"
33 A	33"	10"	12½"
33 B	33"	11"	16"
36 A	36"	10"	12½"
36 B	36"	11"	16"

Proposed design of engine-truck wheels for use on new and existing locomotives

The sub-committee on Stresses in Locomotive Rods and Motion Work recommends holding in abeyance the formulation of a standard set of rules for determining stress allowances in alloy-steel rods and other motion work of light sections in view of the limited experience with parts of such design.

A subcommittee recommends that the proposed simplified-practice recommendations for machine, carriage and lag bolts submitted on August 20, 1937, by the National Bureau of Standards of the United States Department of Commerce be adopted as recommended practice of the association.

The report was signed by H. H. Lanning (chairman), mechanical engineer, Atchison, Topeka & Santa Fe; H. P. Allstrand (vice-chairman), principal assistant superintendent motive power and machinery, Chicago & North Western; G. McCormick, general superintendent motive power, Southern Pacific; W. F. Connal, mechanical engineer, Canadian National; J. E. Ennis, engineering assistant, New York Central; L. H. Kueck, chief mechanical engineer, Missouri Pacific Lines; J. B. Blackburn, mechanical assistant to chief mechanical officer, Chesapeake & Ohio; K. Cartwright, mechanical engineer, New York, New Haven & Hartford; Henry Yoerg, general superintendent motive power, Great Northern; G. C. Christy, superintendent motive power, Illinois Central; E. L. Bachman, general superintendent motive power, Pennsylvania, and W. R. Hedeman, engineer of tests, Baltimore & Ohio.

The report was approved and recommendations ordered submitted to letter ballot.

Steam Locomotive Development

Five meetings have been held since the appointment of your Committee on Further Development of the Reciprocating Steam Locomotive, at which all of the members have either been present in person or represented. The various phases of the work of

the committee have been assigned to a number of small subcommittees, as follows: (1) technical, (2) cylinders and valves, (3) boilers, (4) design. These subcommittees have each held a number of meetings.

As a result of the study given the subject of a reciprocating steam locomotive to produce a sustained speed of 100 m. p. h. on straight level track with a 1,000-ton trailing load, the following definite specifications have been agreed to:

(1) 4,000 draw-bar horsepower, as required for a 1,000-ton trailing load at 100 m.p.h. sustained speed
(2) Cylinder hp. 6,400
(3) Four-cylinder engine
(4) Approximately 300 lb. boiler pressure—750 deg. F. steam temperature at the boiler
(5) Conventional radial-stay type boiler
(6) Factor of adhesion, 4.5 if possible
(7) Boiler to be able to supply 100 per cent cylinder demand plus steam demand for auxiliaries
(8) Calculations to be based on bituminous coal having 12,000 B.t.u.
(9) Design of locomotive to be of conventional type with provisions made for streamlining
(10) Driving-wheel arrangement to be 4-4 coupled
(11) Engine designed for maximum curvature of 18 deg.
(12) Driving-wheel diameter, 84 in. preferred
(13) Anti-friction journal bearings throughout

The committee will proceed on the above outlined fundamental basis in working up the recommended design and does not anticipate going into details only in so far as necessary to support its recommendations.

In its investigation of the problem of improving present designs of reciprocating steam locomotives, the committee has recognized the importance of conveying the steam from the boiler to the cylinders with the least possible loss of pressure and at this time suggests to the members of the Mechanical Division that the matter of steam passages from the throttle through the dry pipe, superheater steam pipe, cylinders, both live and exhaust passages, be carefully analyzed as this, in our opinion, holds promise of increased efficiency in the performance of many existing locomotives. Furthermore, the committee also suggests a closer study and policing of detail parts of existing locomotives.

Further recommendation for the particular problem in question, it is the committee's intention to study and analyze various detailed designs of the major component parts of locomotives, such as boilers, valves, valve gears, superheaters, machinery, counterbalance, etc., with the idea of submitting recommendations covering improvements in existing steam locomotives.

A special subcommittee of your committee observed actual road dynamometer tests on the 4-6-4 N. Y. C. locomotive and collected data, which will be supplemented by actual observations of road tests of the Santa Fe 4-8-4 locomotive at an early date. All of this data will be compared with the Pennsylvania Altoona test-plant data and Santa Fe 4-6-4 road test data now collected. Following the analysis of this test data, it is possible that some change may be recommended in the fundamentals mentioned in this report.

Your committee wishes to acknowledge the co-operation of the New York Central, Pennsylvania, and Atchison, Topeka & Santa Fe in making this information available.

Minority Report Submitted by J. E. Ennis

In dissenting from the majority report, J. E. Ennis, engineering assistant, New York Central, made the following statement:

The committee has assigned to itself, and up to the present time has devoted its sole attention to, the design of a reciprocating steam locomotive capable of hauling a train of 1,000 tons at a sustained speed of 100 m. p. h. on level tangent track.

To meet these conditions, the committee proposes a locomotive with four cylinders and four driving axles, to develop 4,000 hp. at the draw-bar and 6,400 cylinder hp. There are little test data to substantiate these horsepower requirements, and there are some data indicating that considerably less horsepower would be required at the cylinders.

There are in existence and available, locomotives with two cylinders and three pairs of driving wheels, which it is reasonably sure could either meet the assumed requirements or approach them very closely, and it is believed that the committee should have thoroughly explored the possibilities of these locomotives before committing itself to an experimental design of the type proposed. If none of these locomotives could fulfill the stated conditions, there is the practical certainty that a locomotive of proper design with two cylinders and four pairs of driving wheels would suffice, thus providing a locomotive of known conventional type, commonly acceptable to the railroads, which should be lower in first cost and cheaper to operate and maintain, than the very unusual design proposed by the committee.

The report was presented by Chairman D. S. Ellis, chief mechanical officer, Chesapeake & Ohio, Cleveland, Ohio; Vice-chairman W. I. Cantley, mechanical engineer, Association of American Railroads, Chicago; W. R. Hedeman, engineer of tests, Baltimore & Ohio, Baltimore, Md.; J. E. Ennis, engr. asst., New York Central, New York; W. R. Elsey, mechanical engineer, Pennsylvania, Philadelphia, Pa.; J. M. Nicholson, mechanical supt., Atchison, Topeka & Santa Fe, Topeka, Kan.; Lawford H. Fry, railway engineer, Edgewater Steel Company, Pittsburgh, Pa.; W. E. Woodward, vice-president, Lima Locomotive Works, Inc., New York; H. Glaenzer, vice-president, Baldwin Locomotive Works, Philadelphia, Pa.; J. B. Ennis, vice-president, American Locomotive Company, New York; E. G. Bailey, vice-president, Babcock & Wilcox Company, New York; Edward C. Schmidt, professor of railway engineering, University of Illinois, Urbana, Ill.

(The report was accepted as a progress report, the committee given a vote of thanks and assured of the whole-hearted support of the general committee in its further work. The committee was instructed to work up plans for testing the latest types of steam locomotives using a dynamometer car where necessary, and submit recommendations to the general committee. These tests are to include the latest type of four-cylinder locomotives now in service.)

Car Construction

Designs of Standard Cars

On January 25, 1938, a joint meeting was held of the full Car Construction Committee and the Freight Car Design Committee of the American Railway Car Institute for the purpose of making plans for economic study and development of lightweight car designs, in line with the program of 1932. It was agreed that the initial studies would be based on the box car having inside dimensions of 40 ft. 6 in. long, 10 ft. high at the eaves and 9 ft. 2 in. wide and that the types of construction to be developed under this further cooperative effort of the car builders, the railroads and the specialty manufacturers would be as follows: (a) improved and lightened design in carbon-steel riveted construction; (b) same as (a) except alloy steel with combination of welding and riveting; (c) alloy steel

New House Type and Hopper Cars Ordered June 10, 1937, to May 4, 1938

Design	No. of cars	Per cent of total
A. A. R. throughout or conforming closely thereto, including lightweight alloy steel to A. A. R. base designs; house cars to the larger inside clear dimensions; box, except underframe with floating center sills, and hoppers with inside dimensions to meet specific conditions	8,640	87.63
Not A. A. R. except new standard center-sill section and 25¾-in. truck-center-plate height	1,175	11.92
Not A. A. R.	45	.45
Total	9,860	

NOTE: In addition to the house and hopper type cars, orders were placed for refrigerator, gondola, ballast and special type cars which bring the total cars ordered up to 12,460, of which 12,065, or 96.83 per cent, have a standard center-plate height of 25¾ in.; 350, or 2.81 per cent, have 26¾ in. center-plate height, and the remaining 45 cars, or 0.36 per cent, have special center-plate heights. With the exception of refrigerator cars, no standard designs of these types have been requested or produced.

largely of welded construction; (d) combination of carbon steel riveted and welded construction. Some work has been performed but progress only can be reported at this time.

After the box-car design is disposed of, it is planned to proceed with the automobile car of both 40 ft. 6 in. and 50 ft. 6 in. inside length and then later to take up the study of hopper cars.

Standard Refrigerator Car

In accordance with program as outlined in the 1937 report of the Construction, the development of a design for a standard refrigerator car for freight service has been proceeded with in

cooperation with the A. R. C. I. and the Refrigerator Car Operators' Committee, resulting in formulation of specifications covering fundamentals of design as agreed upon by all concerned.

In view of studies now being made to effect further reductions in weight by the use of alloy steels and welded construction, it has been decided that it would not be advisable at this time to prepare a complete set of detail drawings covering the refrigerator car and that under the circumstances the matter would be properly protected by adherence to standard general dimensions and other basic features as covered by the specifications which are included as part of this report. *Recommended for letter ballot.*

Specification for Standard Freight Refrigerator Car

(Iced, Ventilated Type, Suitable for Fruits and Vegetables)

1—*General*—Cars, when delivered shall be complete in all parts ready for service and shall conform to the following specifications which are intended to cover general construction features and assembly practices.

2—*Material*—All material shall conform to A.A.R. specifications or to those of the purchaser provided the requirements of the purchaser's specifications are equivalent to those of the A.A.R. All steel plates ¼ in. and less in thickness, and pressed parts made therefrom shall include a copper content of not less than 0.20 per cent.

3—*Workmanship*—(a) All work must be laid out to template to insure interchangeability and proper assembly of parts.

(b) All rivet holes through draft sills and parts riveted to draft sills, also in bolsters and center sills at bolsters must be punched to the exact size of the rivet and reamed 1/16 in. larger than the diameter of the rivet except where otherwise specified on drawings. The holes must register and rivets must have full bearing through each part. If necessary to ream the holes more than 1/16 in. larger, the size of the rivets must be increased proportionally. All rivets in bolster center fillers to be driven by machine wherever possible. All other rivet holes in car must register and have full bearing all around for the rivet. The use of drift pins more than 1/16 in. larger in diameter than rivets will not be permitted. All parts must be securely and tightly clamped together before riveting and in no case must the rivets be depended upon to draw the parts together. Rivets, after they are driven, shall completely fill the holes, and shall have heads, of the proper shape lying tightly against the sheets or castings.

(c) Flanging of sheets must be true to shape to provide close contact with contiguous parts.

(d) Joints in super-structure and roof must be water tight.

(e) Side bearing clearance shall be adjusted within the limits of ⅛ to ¼ in. per bearing and shall be measured at each bearing with car on level tangent track with car body level. Total side-bearing clearance at BR and AL corners, must be made the same as total clearance at BL and AR corners with permissible variation not to exceed ⅛ in.

4—*General Dimensions*—Nominal capacity, 40 tons; inside clear length between bunkers, 33 ft. 2¾ in.; inside width between lining, 8 ft. 3 in.; inside height, floor to ceiling, 7 ft. 9 in.; inside height, floor rack to ceiling, min., 7 ft. 3 in.; height of floor rack, max., 0 ft. 6 in.; clearance under floor rack slats, min., 0 ft. 4¾ in.; capacity of ice bunkers (263 cu. ft.), nominal, 10,000 lb.; width of side door opening, min., 4 ft. 0 in.; height of side door opening, min. 6 ft. 6 in.; height from rail to floor, minimum, 4 ft. 2 in., maximum, 4 ft. 4 in.; center-plate height, 25¾ in.

5—*Car Structure*—To be of steel-sheathed, wood-lined type, following as closely as practicable the A.A.R. steel-sheathed box-car design, with alternate consisting of steel super-structure framing with wood sheathing and wood lining. Underframe of same design and of same length and width as for the 1932 A.A.R. steel-sheathed box car.

6—*End Construction*—To be of steel, design and application corresponding to the A.A.R. standard steel-sheathed box car and to meet necessary strength requirements.

7—*Roof*—To be of the solid steel type with a heavier sheet around the hatch openings.

8—*Side Doors*—Conventional hinged two-piece plug type.

9—*Insulation*—Side and ends, 3 in.; floor and roof, 3½ in. Based on the use of insulation material having a thermal conductivity not to exceed 6.24 B. t. u. per inch of thickness per square foot per deg. F. difference in temperature for a 24 hour period. Insulation should preferably be applied in blanket form with suitable backing and applied in continuous blankets extending from door post to corner post or around the end to opposite door post, in the floor between the side sills and end sills and on the roof between side plates and hatch openings.

10—*Floor*—Floor to be thoroughly waterproofed with waterproofing extended to the height of floor-rack hinge bolts.

11—*Floor Racks*—To be of hinged sectional type.

12—*Ice Bunkers and Bulkheads*—Ice bunkers and bulkheads to be stationary and of the conventional basket type, with an insulated lining on the side of bulkhead toward lading. Provision for stage icing optional.

13—*Well Traps*—Should be designed to permit of easy access for cleaning and to have cover arranged to form water seal and must be of ample capacity for maximum meltage of ice. Drain tubes should be located to avoid dripping on journal box.

14—*Hatch Openings and Frames*—To be the present A. A. R. standard, except that the fillet in corners of hatch openings should have a radius of 1½ in., with hatch plugs and covers of detachable hinged type. Ice hatches to be beveled at bottom to facilitate full icing at center of bunkers.

15—*Threshold Plates*—Should be raised sufficiently, or other provision made to divert the flow of water, caused by melting ice, away from the threshold plate and thereby prevent seepage under door. Consideration must also be given to the proper breaking of heat flow through the threshold plate.

16—*Body Center Plates*—Drop forged to A. A. R. dimensions. Top and bottom bearing surfaces to be smooth, true and parallel

17—*Draft Gears*—Friction type of capacity meeting A. A. R. specifications and to fit 24⅝ in. pocket.

18—*Couplers*—A. A. R. Type E with 6¼ in. by 8 in. shank, bottom operated. See Plate D for alternates.

19—*Uncoupling Arrangements*—Rotary bottom operated from one side at each end of car, with malleable-iron, cast-steel or forged-steel brackets. See Plate D covering alternates.

20—*Striking Casting*—Cast steel with separable coupler carrier. See Plate D for alternates.

21—*Safety Appliances*—To conform with the latest Interstate Commerce Commission and A. A. R. requirements.

22—*Air Brakes*—AB freight car brake equipment. Brake pipes to be the standard for brake equipment and to have smooth edges free from fins and burrs. A thin coat of graphite grease shall be applied to male threads only and care shall be taken to keep the grease from the inside of pipe and fittings. Connections shall be tested under not less than 70 lb. gage pressure, using soap suds to determine leaks. The completed brake installation shall be finally tested to determine that it operates properly and that there are no interferences. A metal plate showing brake-lever dimensions is to be applied in a visible location near air-brake markings. See Plate D covering alternates.

23—*Hand Brake*—Geared type meeting A. A. R. and I. C. C. requirements.

24—*Trucks*—To conform to the limiting dimensions shown on Plate 60 and A. A. R. specifications for strength requirements. Wheels, axles, journal boxes and contained parts to be in accordance with A. A. R. standards. See Plate D for alternates. The use of non-harmonic truck spring arrangement is recommended for all new refrigerator cars.

25—*Painting*—The purchaser shall furnish the builder all necessary information relating to paint, marking, lettering and stamping desired, in addition to that covered by A. A. R. requirements. All metal parts shall be free from scale and rust and thoroughly cleaned before they are painted. All metal in contact with wood or metal and where not accessible after assembly must be covered with one coat of approved paint before assembling. Both sides of all-steel roofs, outside and inside of superstructure, underframes and trucks (except wheels, axles and parts contained in journal boxes), to be painted in accordance with requirements of the purchaser.

Report of Joint Sub-Committee on Side Frames and Bolsters

During the past year new designs of cast-steel side-frames successfully passed both static and dynamic tests, or slightly modified designs of side frames, already tested and approved,

were approved for use in interchange service to the number of 16. These included two alloy-steel and four carbon-steel 40-ton spring-plankless designs, seven alloy-steel and two carbon-steel 50-ton spring-plankless designs, and one alloy-steel 70-ton design with spring planks. There were 13 new bolster designs which successfully passed static tests or slightly modified designs previously tested which were approved, including two alloy-steel and four carbon-steel 40-ton spring-plankless types, six alloy-steel 50-ton spring-plankless types, and one alloy-steel design for a 70-ton spring-plankless truck. The designs include the Barber stabilized trucks and self-aligning trucks.

Reference was made in the 1937 Report of Car Construction Committee to the new designs of pressed and welded rolled-steel frame and bolster for 50-ton capacity cars submitted for approval by the United States Steel Corporation. The bolster which successfully passed static tests conducted by the sub-committee was approved for use in interchange service to the extent of 50 car sets as referred to in the above mentioned report and was later increased to a maximum of 1000 car sets. The pressed and welded rolled-steel side frames successfully passed static test conducted by the joint sub-committee but as this frame has not yet passed the required dynamic test, approval has been withheld. Other applications pending include side frames for a 40-ton and a 70-ton truck, each spring-plankless and of carbon steel, and one 50-ton alloy-steel design for a truck with spring plank.

In the list of side-frame and bolster designs approved is included the Simplex truck manufactured by the American Steel Foundries who were given authority March 25, 1936, to furnish not to exceed a total of 562 car sets of 40-, 50-, or 70-ton capacity for experimental applications and the National Type C truck manufactured by the National Malleable and Steel Castings Company who were authorized Sept. 11, 1936, to furnish not to exceed 50 car sets of either 40-, or 50-ton capacity for experimental application. The list also includes 40-fon capacity, Grade B, carbon-steel quick-wheel-change trucks submitted by the Four-Wheel Truck Association which has been approved for experimental application to two John Morrell & Company and two Armour Car Line Cars. Included is also a spring-plankless cast-steel side frame made from Grade B carbon steel submitted by the Unit Truck Corporation for approval for application to not more than 50 cars in interchange. This frame embodies a new departure in truck construction including a special type of one-piece brake beam engaging in a guide cast integral at the lower inside edge at truck side frame, thus doing away with the conventional brake-beam hangers and brackets.

Proposed Restrictions in Interchange of Older Types of Truck Side Frames

At a regular meeting of the Committee on Car Construction, recommendations were made to modify Interchange Rule 23 covering autogenous welding limits and regulations to prohibit welding of cracks and fractures and building up of worn surfaces on L- and T-section cast-steel side frames. Subsequently the General Committee concurred in this recommendation and in addition thereto, recommended the revision of Rule 3 Section (t) and of Rule 19 to prohibit the application of welded L- and T-section side frames to all cars in interchange, and this is to be included in the Arbitration Committee's report this year.

Ultimate Results

Although the above is a step in the right direction and should produce good effects, ultimate results will depend almost entirely on the extent to which the member roads interest themselves in the elimination from service of questionable side frames, irrespective of design, age or section, which obviously should not be continued in service. Some railroads have found it very desirable to institute reports of all defective cast-steel side frames found on system cars, with a view to discovering the patterns giving the most trouble and putting in force such rules as are necessary properly to safeguard operation.

About five years ago, one large road instituted a means of close control over this matter by the following procedure:

Monthly reports are made of all cast-steel side frames removed from service account defects as found on inspection of cars appearing in shops or on repair tracks. These reports are made from each point regardless of whether or not defective frames are found. In addition, separate investigations are made of each frame failure in service, the results of which are recorded and reported with complete information as to the location and character of the failure, type, pattern number, and marking on the frame, from which its age and history can be checked.

From the above reports records of performance of each frame pattern are maintained. When this performance becomes unsatisfactory, as gaged from total number in service, percentage of removals for defects, number of failures in service causing derailments and train delays, age and design, the frame is designated for scrapping outright, regardless of the condition of the others, when cars so equipped are retired. If it is desired further to expedite removals from service, frames so designated are scrapped when removed from cars appearing on repair tracks.

The general side-frame situation with respect to the above conditions, also number of serviceable frames in stock and replacement frames required, is reviewed jointly every six months by the purchasing, stores, maintenance and engineering departments for the purpose of making revisions as necessary or desirable in the written instructions which are maintained in the hands of all concerned.

All other cast-steel side frames, regardless of design, age or section, when removed for any purpose, are subjected to thorough cleaning and careful inspection and if found in serviceable condition are placed in stock for further use; otherwise they are immediately scrapped.

Further Recommendations

It is the recommendation of your committee that, through proper A. A. R. channels, the need for a definite and systematic procedure, equivalent to the above, be brought to the attention of the member roads and private car owners, and then followed up with them as may be judged desirable or necessary.

Definitions and Designating Letters for Freight and Passenger Cars

During the past year the committee has passed upon a large number of requests from the members for designating letters for new types of passenger and freight cars. When such requests are received your sub-committee first reviews them, and in cases where it is found that designating letters already in the Manual cover the cars in question, the car owner is so notified by the secretary. A large number of such cases have been so handled this past year.

The committee recommends the following:

Changing of the definition PC to read:

"PC—Passenger, Parlor, or Chair Car. A car fitted with individual or movable chairs and having toilet and washroom facilities. May be equipped with bar. Sometimes provided with barber shop and bath."

The addition to the Manual of the designation *"LC—A house car with side doors and roof hatches. May be equipped with end doors."*

The committee has also passed favorably upon a number of cases of modifications of definitions of designating letters now in the Manual. The object of these suggested changes is to simplify the Manual and eliminate some of the designations which are superfluous. These latter recommendations are being reviewed by other interested divisions of the Association and will, at a later date, be submitted to the members for approval by letter ballot.

Interchange Rule 3 on New Designs of Freight Cars

During the current year the committee reviewed the following designs with trucks in accordance with the provisions of the first paragraph of Interchange Rule 3:

Light-weight steel-sheathed automobile car 50 ft. 6 in. long, with special design of underframe; 700 cars. Light-weight steel-sheathed box car 40 ft. 6 in. long, with special design of underframe; 1900 cars. Both for the Union Pacific; both approved.

70-ton side-dump hopper cars of copper-bearing steel for the Elgin, Joliet & Eastern. Center sills consist of two 13-in. 40-lb. channels with ⅜-in. by 21-in. cover plate.

American Car and Foundry Company underframes, anchorage and car structure parts for transportation of 15 one-ton chlorine containers each. Designs (2) approved; 9 cars.

Pullman-Standard Car Manufacturing Co. light-weight steel-

sheathed box car 40 ft. 6 in. long. Special all-welded design; 200 cars.

Journal Boxes and Details

The annual report for 1937 contained certain recommended changes in the width of the opening at the back end of the box as given in the table on Page 32 of D. V.-920.

Following a conference with the side-frame manufacturers, it now develops that minor corrections in some of these dimensions are considered necessary to prevent, under extreme worn conditions, the distortion of the back opening in the box and the possible crushing of the dust-guard sides.

The following table shows the proposed changes to provide uniform clearance between the axle and the inner opening of the box for all sizes of journals, also the width dimension of the back wall opening restored to the standard prior to 1937:

	Back wall opening			Inner wall opening		
Journal size	Std. prior to 1937	Adopted 1937	Proposed	Std. prior to 1937	Adopted 1937	Proposed
5 in. by 9 in. ...	7½ in.	7 in.	7½ in.	6¾ in.	7 in.	7 in.
5½ in. by 10 in..	8 in.	7¾ in.	8 in.	7⅜ in.	7¾ in.	7½ in.
6 in. by 11 in. ..	8¼ in.	8¼ in.	8¼ in.	8 in.	8¼ in.	8⅛ in.
6½ in. by 12 in..	9¼ in.	9¼ in.	9¼ in.	8½ in.	9¼ in.	8⅝ in.

It is recommended that these changes, which will provide sufficient clearance at the inner axle opening of the box with a minimum amount of change in patterns, be submitted to letter ballot. If approved, the drawings in the Manual and Supplement to the Manual will be revised accordingly.

Other Items

The committee called attention to the fact that the final report of the Impact and Live-Load Tests of Pullman-Standard Welded Box Car No. 501 has been completed, and that the secretary has been instructed to circulate it to all voting members as well as to the A. R. C. I.

Changes desired in the A. R. E. A. clearance diagram marked "Unrestricted for Main Lines" were made and approved by the A. R. E. A. at its last annual meeting and will be incorporated in its Manual as Fig. 10. This will also be included in the Supplement to the Mechanical Division Manual in addition to Plate B for "Unrestricted Interchange Operation" which is to be retained.

A sub-committee has been appointed to check the lettering and marking for auto rack cars with the members for the purpose of determining whether a changed system of classification which can be kept up to date more conveniently is not desirable.

The joint sub-committee to consider the adjustment of rail-load limit capacity to compensate for various weight wheels now in general use proposes the addition of a note to Interchange Rule 86 to compensate for the average difference in weights. This has been approved by the Arbitration Committee and will be considered by the Car Construction Committee at its next meeting.

The report was signed by P. W. Kiefer (chairman), chief engineer motive power and rolling stock, New York Central; T. P. Irving (vice-chairman), engineer car construction, Chesapeake & Ohio; W. A. Newman, chief mechanical engineer, Canadian Pacific; J. McMullen, superintendent car department, Erie; F. A. Isaacson, engineer car construction, Atchison, Topeka & Santa Fe; G. S. Goodwin, assistant to general superintendent motive power, Chicago, Rock Island & Pacific; H. L. Holland, assistant engineer, Baltimore & Ohio; E. B. Dailey, engineer car construction, Southern Pacific; J. T. Soderberg, general foreman, Pennsylvania; T. M. Cannon, engineer car construction, Chicago, Milwaukee, St. Paul & Pacific; H. E. Myers, master car builder, Lehigh Valley, and F. J. Jumper, general mechanical engineer, Union Pacific.

The report was approved and recommendations of the committee ordered submitted to letter ballot.

Revision of postal-car specification originated with a communication received by the secretary early in 1937 from the Second Assistant Post Master General suggesting review of specifications for postal cars with particular reference to cars and appartments of lightweight high-speed trains being placed in service. The annual report for this year from the mechanical engineer of the Mechanical Division is to contain a report on the development and status of this subject.

Report on Wheels

It has been suggested to the committee that tape sizes for cast-iron wheels be defined as 1/16 in. rather than ⅛ in. circumferential dimension in order that in the selection of wheels for physical tests, should the wheels of one designated tape size fail, advantage could be taken of the next tape dimension. This would provide for test groups to vary by one-half tape instead of full tape size.

The ⅛-in. tape dimension has been so long established and so generally recognized as a unit of wheel circumference measure that the committee does not approve changing the unit tape size of ⅛ in., but is agreeable to revising the section of the cast-iron wheel Specification M-403-36 so that advantage can be taken of half tape sizes in the selection of wheels for physical tests.

It is also recommended that in each of the paragraphs under consideration for revision that the words "and cast date" be added.

Out-of-Round Tolerances—New Cast-Iron Wheels

Consideration has been given to the question of reducing the out-of-round tolerance on new cast-iron wheels. The committee realizes the extent to which damage to equipment and lading occurs from out-of-round condition of wheels, but is not in position to make a recommendation at this time. Advice has come to the committee that certain roads are purchasing and placing in service ground cast-iron wheels and some roads are following the practice of grinding wheels after mounting, which the committee considers is a most desirable practice. Information from roads following these practices as to service results is earnestly solicited.

Your committee has been solicited to establish certain symbols to represent loading capacity of lightweight cast-iron wheels. The committee recognizes there may be some merit to such an arrangement should the lightweight cast-iron wheel be adopted as standard.

Authorization of Use of Experimental Cast-Iron Wheels

In the 1937 report attention was directed to an experimental type 750-lb. 33-in. single-plate cast-iron wheel, the special features of this wheel being the cored hub and brackets supporting the inside of the rim. Authority had been issued the manufacturers to construct as many as 10,000 of these wheels; the same to be identified as experimental design by the mark "AAR-X."

Further development on the part of the Association of Manufacturers of Chilled Car Wheels resulted in the production of a lightweight cast-iron wheel suitable for the same capacity loading as the 750-lb. wheel. This lightweight wheel was to weigh 695 lb. in the rough, 685 lb. finished. Request for the application of 10,000 of this design of wheel carrying with it cancellation of the authority for 10,000 750-lb. wheels, of which a balance of 7,600 remained unapplied, was granted by the General Committee, these wheels to carry the AAR-X experimental wheel marking.

Another request was received for authority to apply 10,000 cored-hub, bracketed-type wheels for mounting on 6-in. by 11-in. axles. Three thousand of these wheels were on order from a member road. In consideration of this request authority was granted for the 3,000 wheels on order, the subject being left open for consideration should additional groups of wheels of this capacity be requested by member roads.

In connection with these lightweight experimental cast-iron wheels, the committee feels that a careful study should be made of two conditions, relating to this design, namely, the effect the cored hub may have upon the finished machining of the bore of the wheel and the effect this partially unsupported wheel fit may have upon the concentration of stresses in the axle. Roads obtaining these cored-hub wheels should give careful consideration to the former item, and the Association of Manufacturers of Chilled Car Wheels should arrange to make a study of the latter, relating to axle stresses.

Chipping Customer's Initials Off Wheels

It has been the practice on the part of cast-iron wheel manufacturers to supply the demand for small groups of wheels

from stock produced for larger customers by chipping the customer's initials from such wheels. While there is only an occasional demand on the part of the manufacturers that requires such action, the committee recommends that this practice be prohibited and when the manufacturer is required to supply wheels under the above mentioned condition that authority be requested of the railroad from whose stock these wheels are to be taken, permitting the railroad's initials to remain on the wheels and reporting to the road for whom they were manufactured the serial numbers of wheels included in such an allotment.

The Association of Manufacturers of Chilled Car Wheels has been doing some splendid research work in an effort to develop a definite and practical means of determining the depth of chill, proceeding along the line of hardness as an index to the character and depth of chill. It has also been demonstrated that the inspectors trained in the art of determining the character of chill in the wheel can very closely approximate in their determinations the results of the hardness test. This study is being continued on the part of the manufacturers and probably by the time another annual report is prepared some more detailed data will be available.

A joint committee selected from membership of the Engineering and Mechanical Divisions has been appointed to make a study as to the relationship between track and rolling stock. The representative on this joint committee from the Wheel Committee reports that one meeting has been held, but no definite program formulated. It is understood that this work is to be carried forward under the chairmanship of Dr. A. N. Talbot of the University of Illinois.

The subject of out-of-roundness has already been mentioned in connection with cast-iron wheel subjects, and it is no less important with respect to wrought-steel wheels as the same degree of out-of-roundness is just as destructive, regardless of the material of which the wheel is made.

In a conference with representatives of the wrought-steel wheel industry the suggestion was made to them that consideration be given to the practicability of reducing the out-of-round tolerance for one-wear and two-wear wrought-steel wheels from the present maximum of $\frac{1}{32}$ in.

Design of Wheels for Streamline Trains

Your committee has been endeavoring to accumulate some definite data with the idea of determining the characteristics of car wheels best adapted to high-speed lightweight streamline trains. There is not sufficient data available to support any definite recommendations, but it may be of interest to know just what the tendencies in this service indicate.

The service mileage of wheels in this class of service is much lower than considered normal for ordinary passenger-car wheels. The performance of wheels indicates that in this particular class of service a special type of wheel must be provided if reasonable mileage is to be secured. It is hoped that your committee, in collaboration with the manufacturers, may, during the coming year, be able to suggest a specification for wheels for such high duty service.

In the study of wheel service it appears the question of braking conditions on these high-speed trains is a matter of worth while consideration by the Brake Committee in an effort to relieve as far as possible the punishment the wheels receive as a result of heavy braking.

In several former reports of the committee reference has been made to the loss of service metal in passenger-car wrought-steel wheels due to development of thermal checks, resulting from severe braking. On certain railroads in some classes of service this trouble is still prevalent. On certain other railroads where special types of wheels have been used to overcome the trouble, it appears to have been largely eliminated. The experience on these latter railroads seems to indicate that where service conditions are such as to make necessary a special type of wheel to resist thermal checking, the best solution is to use wheels with a lower carbon content in the steel and then heat treat to obtain the desired physical properties. The committee does not consider that a special specification is necessary to cover this product at the present time as its use may not be necessary in more than a limited number of special services. Where unusual difficulties of this kind are encountered the committee suggests a trial of special wheels of the above mentioned type which can be secured from any of the manufacturers of wrought-steel wheels.

Wheel Service Records

Appended to the 1937 report of this committee were certain service records reported by three member roads showing the cause for which wheels were removed on these roads during three winter months. In presenting this portion of the report your committee stated it was the intention to supplement this record with a similar record of three summer months in a subsequent report. The roads supplying this information are the same roads included in last year's report and are similarly designated as Roads A, B and C. The arrangement of the data is substantially the same, except that two roads showed the results of removals of multiple-wear and one-wear wrought-steel wheels separately, whereas in last year's report the record of all wrought-steel wheels was combined.

[The report included four tabular exhibits submitted by Road A, two by Road B and two by Road C. For lack of space, the Road A exhibits, only, are included in this abstract of the committee's report.—Editor.]

Table I—Summary of Causes of Cast-Iron Wheel Removals from Foreign Cars on Road A During July, August and September, 1937

Wheels Condemned by Standard Gage

Symbols	Cause of removal	Removed		Per cent			
		Single plate	Double plate	Single plate	Double plate	Total removed	Per cent
73	Worn through chill	1,611	1,021	20.71	15.96	2,632	18.58
72	Seams	768	1,685	9.87	26.37	2,453	17.32
75	Brake burn, cracks	1,859	429	23.90	6.71	2,288	16.15
78-R	Broken rim	749	1,433	9.63	22.43	2,182	15.40
68	Slid flat	695	157	8.94	2.46	852	6.02
73-R	Out of round	491	276	6.31	4.32	767	5.41
75-C	Brake burn, comby	503	196	6.47	3.07	699	4.93
78	Flange, chipped	363	148	4.67	2.32	511	3.61
71	Shelled out	225	160	2.89	2.51	385	2.72
74-V	Flange, vertical	69	242	0.89	3.79	311	2.20
74-T	Flange, worn thin	80	208	1.03	3.26	288	2.03
81-L	Loose wheel	135	88	1.73	1.38	223	1.57
83	Weight less than 650, 700 and 750 lb.	2	155	0.03	2.43	157	1.11
76	Tread worn hollow	66	84	0.85	1.32	150	1.06
78-F	Flange, cracked or broken	81	40	1.04	0.63	121	0.85
71-F	Flat, comby	62	22	0.80	0.34	84	0.59
78-P	Plate, cracked or broken	2	29	0.03	0.45	31	0.22
107	Built up tread	16	4	0.20	0.06	20	0.14
98	Large bore	1	5	0.01	0.08	6	0.04
98-W	No weight cast on wheel	..	4	..	0.06	4	0.03
77	Burst hub	..	3	..	0.05	3	0.02
	Total	7,778	6,389	100.00	100.00	14,167	100.00

Wheels Condemned by Remount Gage

82-W	Tread worn hollow	1,162	1,118	56.14	64.44	2,280	59.92
82	Brake burn, cracks	465	168	22.46	9.68	633	16.64
82-V	Flange, vertical	163	148	7.87	8.53	311	8.17
82-C	Brake burn, comby	182	87	8.79	5.01	269	7.07
82-T	Flange, thing	20	127	0.97	7.32	147	3.86
82-S	Shelled out	68	74	3.29	4.27	142	3.73
82-H	Flange, high	10	13	0.48	0.75	23	0.61
	Total	2,070	1,735	100.00	100.00	3,805	100.00

Defective Axles

Symbols	Cause of removal	Number defective removed	Per cent defective
84	Cut or burnt journal	3,103	96.25
85-C	Long journal	56	1.74
86	Small journal diameter	33	1.02
84-A	Bent axle	14	0.44
86-B	Low center diameter	5	0.16
86-A	Low wheel seat	4	0.12
85-A	Seamy journal	4	0.12
85-D	Broken or worn collar	3	0.09
85	Broken journal	2	0.06
	Total	3,224	100.00

Grand Total

	Second-hand	Defective	Total	Per cent defective
Single-plate wheels	6,827	9,848	16,675	59.06
Double-plate wheels	2,657	8,124	10,781	75.35
Total wheels	9,484	17,972	27,456	65.46
Axles	10,504	3,224	13,728	23.48

On Road A the principal causes for removal of cast-iron wheels was worn-through chill, seams, brake burn cracks and broken rim. The percentage of the total number of wheels removed for these causes ranges from 18.58 per cent for worn-through chill, to 15.40 per cent on account of broken rim.

The principal cause for the removal of multiple-wear wheels on this same road was thin flange, 67.32 per cent having been removed for this cause, while for the one-wear wrought-steel wheels the principal cause of removal was built-up tread, 46.42 per cent, with an appreciable percentage for loose wheels and thin flange.

The most prominent causes for cast-steel wheel removals was shelled-tread and thin flange, 29.73 per cent having been removed for each one of these defects.

On Road B 32.8 per cent of the cast-iron wheels were removed on account of broken rim. The next condition in line of defects was 22.37 per cent removed on account of flat sliding. Of the wrought-steel wheels removed on this road 51.73 per cent were removed for thin flange, 23.87 per cent for high flange or tread-worn hollow. This item of 23.87 per cent represents a favorable condition as it indicates this group of wheels had been subjected to the maximum amount of tread wear.

On Road C, three prominent causes for removal of cast-iron wheels were, worn-through chill, broken rim and seams, these representing 32.53 per cent, 21.58 per cent and 13.22 per cent, respectively. On this same road the wrought-steel wheel removals were 38.10 per cent for worn flange, and 28.57 per cent for slid flat. It will be observed, however, that the number of wrought-steel wheels involved in making up these percentages is rather limited, and therefore does not represent much value from a service-record standpoint as where a greater number of wheels are involved.

Table II — Summary of Causes of Multiple-Wear Wrought Steel Wheels Removed from Foreign Cars on Road A During July, August and September, 1937

Wheels Condemned by Standard Gage

Symbol number	Cause of removal	Number removed	Per cent
74-T	Flange worn thin	894	67.32
79	Thin rim	152	11.44
81-L	Loose wheel	103	7.75
107	Built up tread	92	6.92
68	Slid flat	66	4.97
71-E	Shelled tread (Less than ⅛ in.)	5	.38
76 (HF)	Flange, high	4	.30
74-V	Flange, vertical	3	.23
71-B	Rim, shattered	2	.15
71-D	Sub-surface defect	2	.15
76 (TWH)	Tread worn hollow	2	.15
71-A	Rim, burnt	1	.08
71-S	Shelled tread (⅛ in. or over)	1	.08
80-B	Plate, circumferential crack in	1	.08
	Total	1,328	100.00

Defective Axles

84	Cut or burnt journal	2,004	99.11
85-C	Long journal	10	.49
86	Small journal diameter	3	.15
84-A	Bent axle	2	.10
85-A	Seamy journal	1	.05
85	Broken journal	1	.05
85-D	Broken collar	1	.05
	Total	2,022	100.00

Grand Total

	Second-hand	Defective	Total	Per cent defective
M. W. wrought-steel wheels..	4,450	1,328	5,778	22.98
Axles	867	2,022	2,889	69.99

Table III — Summary of Causes of One-Wear Wrought-Steel Wheels Removed from Foreign Cars on Road A During July, August and September, 1937

Wheels Condemned by Standard Gage

Symbol number	Cause of removal	Number removed	Per cent
107	Built up tread	26	46.42
81-L	Loose wheel	11	19.64
74-T	Flange, worn thin	10	17.85
68	Slid flat	4	7.14
71-B	Rim, shattered	1	1.79
71-C	Rim, spread	1	1.79
74-V	Flange, vertical	1	1.79
77	Burst hub	1	1.79
79	Thin rim	1	1.79
	Total	56	100.00

Wheels Condemned by Remount Gage

82-T	Thin flange	2	100.00
	Total	2	100.00

Defective Axles

84	Cut or burnt journal	194	100.00
	Total	194	100.00

Grand Total

	Second-hand	Defective	Total	Per cent defective
One-wear wrought-steel wheels	404	58	462	12.55
Axles	37	194	231	83.98

Table IV — Summary of Causes of Cast-Steel Wheel Removals from Foreign Cars on Road A During July, August and September 1937

Wheels Condemned by Standard Gage

Symbol number	Cause of removal	Number removed	Per cent
71	Shelled out	22	29.73
74-T	Flange, worn thin	22	29.73
78-P	Plate, cracked or broken	11	14.87
81-L	Loose wheel	7	9.46
76	Tread worn hollow	4	5.41
74-V	Flange, vertical	3	4.05
78-R	Broken rim	2	2.70
72	Seams	1	1.35
73-R	Out of round	1	1.35
78-B	Bracket cracked or broken	1	1.35
	Total	74	100.00

Wheels Condemned by Remount Gage

82-T	Thin flange	7	53.85
82-V	Vertical flange	4	30.77
82-S	Shelled out	2	15.38
	Total	13	100.00

Defective Axles

84	Cut or burnt journal	88	95.65
85-A	Seamy journal	2	2.17
86	Small journal diameter	1	1.09
84-C	Pitted journal	1	1.09
	Total	92	100.00

Grand Total

	Second-hand	Defective	Total	Per cent defective
Cast-steel wheels	201	87	288	30.21
Axles	52	92	144	63.89

Revision of Wheel and Axle Manual

In the revision of the Wheel and Axle Manual there are so many pages in which changes are involved that it was decided to reprint the manual, and it is hoped before the year is over the association will be in position to authorize this action being taken.

Observation of wheel-shop practices, as evidenced by wheels coming into the shops of committee members, indicates the need for more refined workmanship, and it is urged that member roads take occasion to look into the manner in which wheel and axle work is being performed.

The committee wishes to take this means of expressing its appreciation of the splendid co-operation it is receiving from the representative wheel manufacturing interests. The committee feels we are now in the midst of a period of wheel development brought about by the endeavor on the part of the manufacturers to meet various exacting service conditions, and realizing the importance of service demonstrations, solicits the patronage of the railroads so that opportunity may be afforded the manufacturers for developing the merits of their improved products.

Summary of Recommendations

Revision of Cast-Iron Wheel Specifications—It is recommended that the specifications for cast-iron wheels, M-403-36, be revised by inserting the underscored words *"full or half"*

tape size *"and cast date,"* in paragraphs 5 (c), 6 (a), 7 (a), 8 and 11 (b).

It is recommended that the dimensions referred to in Sec. 4 (b), Dimensions—second sentence be changed to read: *"¼ in. above or 5/16 in. below."*

After the second sentence in Sec. 4 (c), Taping, insert *"A tape size is considered that of the lower gradation until the next higher gradation is reached."*

Par. 5 (b)—Drop Test—Change the word *"on"* a concrete foundation to *"or"* a concrete foundation.

Master Gages—In the design and development of master gages for condemning worn condition of gages used in connection with wheels it was necessary to establish a dimension to represent the result of wear beyond which dimension the gage would be condemned. Dimension 0.015 in. which corresponds to 1/64 in. was established as a basis for the development of these master gages.

The gages developed for this purpose are shown as Figs. 35 to 42 inclusive, and are presented for approval of the association. [Note: In order to avoid expense, prints of the gages referred to were omitted from this report. Cuts will be made for the Letter Ballot Circular.]

Symbols.—It is recommended that defect symbol 83-A be adopted to represent "Cast-Iron Wheels cast prior to January 1, 1921" (Rule 83).

Recommendations to Arbitration Committee with Reference to Changes in Interchange Rules

Rule 76—Tread Worn Hollow—Where the tread-worn hollow defect refers to cast-iron wheels, insert *"One Wear"* before cast-steel wheels.

Where the tread-worn hollow defect refers to wrought-steel wheels, after wrought-steel insert *"and Multiple-Wear Cast-Steel Wheels."*

If the aforegoing recommendation is approved, similar change should be made in P. C. Rule 7, Sec. (f), Par. 4, and the title under Fig. 91, page 126 of the Wheel and Axle Manual should be changed to read: *"Tread Worn Hollow Condemning Limit Gage for Cast-Iron and One-Wear Cast-Steel Wheels."*

Rule 75—Brake Burn Cracks—Insert a note establishing a definite dimensional limit for transverse cracks approaching the flange of the wheel.

A similar note should be added to P. C. Rule 7, Sec. (f), Par. 3.

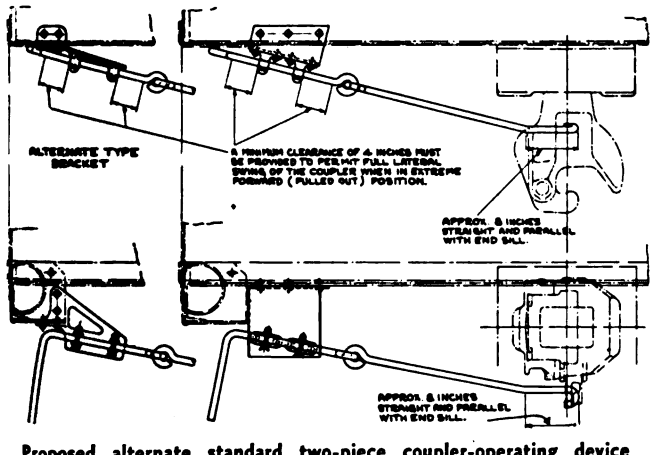
Rule 73-A, Out-of-Round—Revise by inserting "One-Wear" before cast-steel and "One-Wear" before wrought-steel wheel references.

If the above recommendation is approved, the title under Fig. 76-A, Page 116 of Wheel and Axle Manual should be changed to read: "Gage for Out-of-Round Cast-Iron, One-Wear Wrought- and One-Wear Cast-Steel Wheels."

Rule 82, Broken Rim—It has been recommended that Rule 82 be amplified by the addition of Par. (d) in Rule 82, establishing a remount limit for broken rim.

The report was submitted by Chairman H. W. Coddington, chief chemical and test engineer, Norfolk & Western, Roanoke, Va.; Vice-chairman D. Wood, engineer of tests, Southern Pacific, San Francisco, Cal.; H. H. Haupt, general superintendent motive power, Pennsylvania, Pittsburgh, Pa.; E. E. Chapman, mechanical assistant, Atchison, Topeka & Santa Fe, Chicago; J. Matthes, chief car inspector, Wabash, Decatur, Ill.; A. G. Hoppe, assistant mechanical engineer, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.; A. M. Johnsen, engineer of tests, Pullman Company, Chicago; E. C. Hardy, assistant engineer, New York Central, New York; W. R. Hedeman, engineer of tests, Baltimore & Ohio, Baltimore, Md.

(The report was approved and recommendations ordered submitted to letter ballot. The committee was directed to give serious consideration to reducing the limit of wear of wheels used in high-speed service and to work with the manufacturers in developing the most satisfactory wheel for ultra high-speed service.)

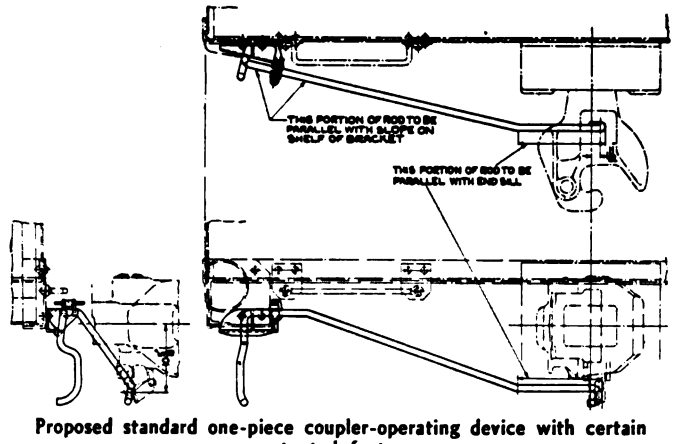


Proposed alternate standard two-piece coupler-operating device licensed to A.A.R.

Couplers and Draft Gears

The tight-lock coupler adopted in 1937 as alternate standard to the standard Type E coupler for passenger service, is receiving further attention on the part of the coupler manufacturers in the nature of refinements of finish during manufacture of certain parts of the coupler relating to the contour lines. These refinements are being worked out to improve the fitting and interchangeability of parts as produced by the different coupler manufacturers.

Up to the present time, orders have been placed upon the coupler manufacturers for approximately 1,000 tight-lock couplers. The reports relating to the service obtained from these



Proposed standard one-piece coupler-operating device with certain patented features

couplers have been gratifying. The Mechanical Committee of the coupler manufacturers is also working on the development of a standard shank or shanks that may be recommended for use in conjunction with tight-lock couplers in passenger service.

Another item in the process of development for use with tight-lock couplers is that of suitable designs of coupler operating rods.

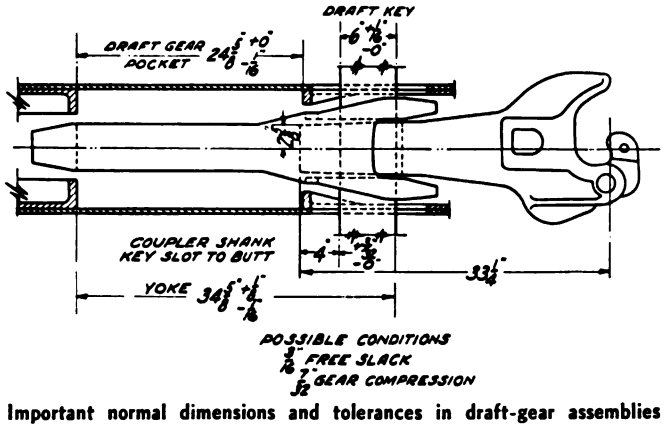
A change has been made in the buffing shoulders of the knuckle and bar in the tight-lock coupler to prevent a worn Type-E knuckle being applied to a tight-lock bar and interfere with its proper operation. This modification was so made that the new tight-lock knuckle will fit the old and new bars, but the old tight-lock knuckle cannot be used in the new bar.

Bottom-Operated Uncoupling Rods for Type E Couplers.—The bottom-operating mechanism of the Type E coupler has been confined to a one-rod type. It has developed that certain features of this bottom-operating rod mechanism are patented, which restricted the source of supply to one manufacturer. The demand for a type of operating mechanism free from any such restrictions has resulted in the development of a two-piece type bottom-operating rod which is comparable in its functioning with the one-piece operating rod.

Both types of operating rods are illustrated. *It is recommended that both types of rods be approved for submission to letter ballot, the one-piece rod to be adopted as standard and the two-piece rod as alternate standard.*

High-Tensile Steel Type E and Tight-Lock Couplers.—Your committee is working with the Mechanical Committee of the coupler manufacturers in the preparation of specifications for tight-lock and Type E couplers in high-tensile steel. When these specifications have been approved by the coupler committee, they will be submitted to the specifications committee for its consideration.

Coupler Shank and Attachment Tolerances.—In the 1937 report of your committee, recommendation was made relating to the revision of manufacturing tolerances of coupler and draft



Important normal dimensions and tolerances in draft-gear assemblies

gear attachments; this recommendation having been based upon observations made in connection with the derailment of a certain lot of new refrigerator cars in which it appeared that restriction in the horizontal angling of the couplers was occurring due to the influence of draft-gear compression forces against the butt of rigid-shank Type E couplers. The subject was referred back to the committee for further consideration.

In the study of this subject, the committee has reviewed present manufacturing practices for couplers and yokes, especially as regards the involved dimensions and variations and concludes that certain changes in limiting tolerances could be made to good advantage. The normal length of the yoke from the rear draft-gear bearing pad to the front of key slot is 34⅝ in. The range in variation in this dimension for each manufacturer is within reasonable limits, but there exists too great a differential between the products of different manufacturers and varies from —⅛ in. to +¼ in.

In checking the length of coupler shank from the back of the key slot to the end of the shank as furnished by several coupler manufacturers, it is again found that the range in variation for each manufacturer is within reasonable limits, but there exists too great a range in the variation as between manufacturers, varying from —1/16 in. to +3/16 in.

A comparison of the key slot to butt dimension on couplers before the butt surface was ground to suit requirements showed similar wide variations. A review of this condition indicates the importance of improving manufacturing practices so that the limits of variations conform to the standard specified and the committee feels that this should be the first action toward improving present conditions. Dimensions and tolerances in accordance with the committee's proposal will provide a maximum 3/16 in. free slack and a maximum 7/32 in. compression when assemblies are made with combinations of dimensions that will develop the two extremes.

The present A. A. R. standards provide for the coupler shank and width of key, but do not provide tolerances for the length of yoke and the length of gear pockets in the sills. Your committee, therefore, recommends that the following tolerances be submitted to letter ballot for adoption as standard:

(1) No change in present standard tolerance governing the length of the coupler shank from the back of the key slot to the end of the shank.

(2) No change in the present tolerance governing the width of the standard draft key.

(3) That the length of the vertical-plane cast-steel yoke be 34⅝ in. from rear draft-gear pad to the front of the key slot, tolerance —1/16 in. and +⅛ in.

(4) That the length of the standard gear pocket in the car sills be 24⅝ in., tolerance +0 in. and —1/16 in.

(5) That the Mechanical Committee of the coupler manufacturers be requested to develop and submit for approval, a suitable gage for measuring the length of coupler yokes and maintaining the tolerances specified, Item 3, above.

Safe-Lock Couplers.—The committee has had on its docket for some time, a suggestion for a safe-lock coupler that would prevent vertical slip-overs and also serve to support a coupler that was pulled from its attachments in the adjacent car. The design suggested was of such a nature that it would not couple with the standard tight-lock coupler and an effort was made to provide a design of safe-lock coupler that would not change the contour lines sufficiently to prevent its use in conjunction with any recognized standard coupler. This matter is also being given consideration by the coupler manufacturers but to date no satisfactory design has been evolved. While this subject is still being studied it is believed that the situation relating to pulled-out couplers and vertical slip-overs is being materially and effectively remedied by the improvements that are being made in draft gears and draft-gear attachments and the more extended use of 11-in. face knuckles.

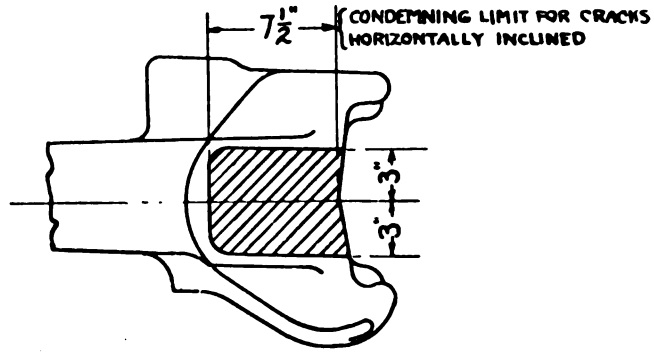
Type E Knuckles Breaking Due to Defective Material.—A few failures have been reported with Type E knuckles breaking in service as a result of defects in manufacture. This matter has been brought to the attention of the coupler manufacturers and an intensive study has been made with the result that considerable constructive information was developed and foundry practices corrected insuring the quality of knuckle castings being maintained to the end that they meet the established strength tests.

Means for Raising Low Couplers.—Your committee has given consideration to recommending some convenient means for maintaining coupler heights in alignment with the draft gears where there is sufficient space between the coupler shank and the striking casting to accommodate the application of a plate between the coupler carrier and bottom of the coupler shank.

Adjustment of coupler height through this means not only brings the coupler in better alignment with the draft gear and attachments, but is an effective means of increasing coupler height, since usually the increase in coupler height is three times the thickness of the shim applied. Recommendation in regard to this subject has been made to the Arbitration Committee together with suggested designs of plates that can be conveniently applied in conforming with this recommendation.

Type D Couplers Opening in Service.—The committee has investigated reports from various railroads that passenger trains were parting where bottom-operated Type D couplers were in use. The investigation disclosed that these partings were principally occasioned by the couplers being equipped with an obsolete design of bottom lock-lift toggle instead of the No. 2 or No. 3 type toggle with the improved anti-creep feature.

On account of the importance of this subject, a circular cover-



Revised Fig. C

ing this condition was prepared and sent out by the secretary as Circular DV-928 dated December 7, 1937. If the suggestions covered in this circular are followed, trouble on account of Type-D bottom operated couplers opening in service due to ineffective anti-creep should be eliminated.

Reclamation of Couplers, Knuckles and Locks.—Present A. A. R. Rule 18, Sec. (a) provides certain limits beyond which a coupler body may be condemned for cracks in the knuckle-tail

side wall, yet still be within limits for reclamation. When such couplers are condemned, the owner is allowed a scrap credit of $1.43 for 6-in. by 8-in. shank Type D coupler body; the coupler body can be reclaimed at a nominal cost in the neighborhood of $2.50 and placed on another foreign car at a second-hand value of $11.76. Questions have also been raised relative to the interpretation of this rule and the limits prescribed in Fig. C. The rule and the limits have received careful consideration by your committee as a result of which the following recommendations are made:

Proposed.—Such crack extends beyond the shaded area, Fig. C, shown on page 56. When crack extends beyond the shaded area, the coupler body is condemned and must not be reclaimed by welding. [Note: Revised Fig. C is illustrated.]

Coupler bodies cracked within the shaded area must have the cracks welded when applied to foreign cars.

If the revision of Rule 18 (a) is approved by the association, Rule 23, Sec. 4, Couplers; Passenger Car Rule 7; and Fig. 5 in the second-hand coupler specifications should be revised to conform thereto.

Cast-Steel Coupler Yokes (Std. Repair Type).—Your committee, in conjunction with the Mechanical Committee of the coupler manufacturers, has made several attempts to design a cast-steel yoke that could be adapted to various draft-gear installations and reduce the number of individual designs the manufacturers are being called upon to supply. Efforts along this line have not been sufficiently satisfying to justify a recommendation. The committee also has under consideration the possibility of using a combination cast-steel head and wrought strap yoke, the head being designed for application with horizontal cross key, and also designed so that the yoke will be secured with short rivets acting in double shear, whereas the same yoke secured to a coupler shank with long rivets would be subjected to single shear.

The study the committee has made of this proposition is not sufficiently advanced to warrant a recommendation at this time.

In conclusion, your committee recognizes the splendid cooperation received throughout the year from the Mechanical Committee of the coupler manufacturers in the advancement of the problems handled by this committee.

The report was presented by Chairman R. L. Kleine, assistant chief motive power, Pennsylvania, Philadelphia, Pa.; Vice-chairman H. W. Coddington, chief chemical and test engineer, Norfolk & Western, Roanoke, Va.; C. J. Scudder, chief motive power, Delaware, Lackawanna & Western, Scranton, Pa.; L. P. Michael, chief mechanical engineer, Chicago & North Western, Chicago; J. P. Morris, mechanical superintendent, Atchison, Topeka & Santa Fe, Ft. Madison, Iowa; H. W. Faus, engineer motive power, New York Central, New York.

Report of Subcommittee on Draft Gears

Two new applications for certificates of approval have been received within the past year. Tests of one of these types are now in progress and the other type will be tested as soon as representative test specimens can be obtained.

During the year, several applications for approval of minor changes in certified gears have been acted upon by the committee. Also, as a result of information uncovered by the annual canvass of the draft-gear manufacturers, several corrections have been made in the records which are on file showing the construction of approved gears.

Steps have been taken to make check tests of the approved draft gears, as provided for in A. A. R. Specifications for Approved Draft Gears, M-901-36, Appendix A, Par. 15. This work is now in progress.

In addition to the work covered by the above projects, the draft-gear testing laboratory has done considerable development work for manufacturers of draft gears and truck springs and has also given some time to perfection of instruments for making draft-gear and truck-spring tests.

At the request of this committee, the Car Construction Committee has made a slight modification in the drawing showing draft-gear carrier used with horizontal yoke, in order to prevent binding of the draft gear under certain conditions in the new Z-section center sill. In this connection closer limits have been set for the external dimensions of approved gears. All draft-gear manufacturers have agreed to be governed by these new limits pending revision of existing specifications which will be deferred for the present in order to save printing expense.

No additional action has been taken on the subject of road tests during the year. It has been continued on the docket because it is felt advisable to make such tests as soon as circumstances warrant.

The subcommittee report was presented by Chairman H. W. Faus, engineer motive power, New York Central, New York; H. W. Coddington, chief chemical and test engineer, Norfolk & Western, Roanoke, Va.; L. H. Schlatter, foreman, Pennsylvania test department, Altoona, Pa., and W. Bohnstengel, assistant engineer of tests, Atchison, Topeka & Santa Fe.

(The report was approved and recommendations ordered submitted to letter ballot.)

Brakes and Brake Equipment

In view of the fact that the size of letters or figures for air-brake markings has been increased from 1 in. to 1½ in., the 3/32-in. bridges now used are too narrow to prevent excessive breakage of stencils. In order to strengthen these stencils and reduce the tendency for breakage, we recommend the adoption of increased width of bridges in stencils to 3/16 in., and that necessary revision be made to figures on pages 118 and 119 of the Interchange Rules and pages E-43 and E-45 of the Manual of Standard and Recommended Practice.

Foreign Substance in Emergency Portion of Type-X AB Brakes

Complaint has been received with reference to various types of plugs used to protect the emergency vent port of the Type AB brake emergency portion when being shipped from shops to various repair points. In some cases common corks have been used and in others metal or wooden plugs covered with rags of various kinds. In applying or removing such plugs, breakage occurs which permits a part of the plug being left in the emergency port and which finds its way under the vent valve, holding this valve off its seat and rendering the valve inoperative.

The air-brake manufacturers, when shipping these parts, close the atmospheric openings with flanged metal thread protectors which are readily removed without possibility of parts being left in the valve structure. This type of plug should be used, or a threaded plug which will screw into the emergency vent port similar to a common pipe plug where the atmospheric opening is threaded, such as applies to all but the earlier types of AB brakes.

We would suggest advising the railroads with reference to this feature, in order that it will not become common practice to resort to plugs of such character that they might inadvertently enter the operating parts either when being applied or removed from the valve openings.

Wasp Excluder for Retaining Valve

The committee has for the past several years endeavored to provide a simple and inexpensive means of protecting the freight retaining valve against stoppage of the exhaust port by mud-bees and wasps. The member roads have tried out two different types of brass plugs having slotted openings. The first type proved unsatisfactory because of being affected by sleet and ice in winter weather. The second type overcame this difficulty but does not provide a large enough dirt compartment so that it will run throughout the ordinary cleaning period for brake equipment without the openings being restricted or closed.

This question has been gone over with the air brake company with a view of re-designing the retaining-valve body so that a larger exhaust opening may be provided which will overcome the inherent faults of the above plug type protectors. This feature is now being developed and if it proves satisfactory, a practical device can be introduced into service through the ordinary renewals of retaining valves.

Brake-Beam Tension-Rod Nuts

The Chicago Railway Equipment Company has developed a sleeve nut which has the seat of the nut chamfered off to provide a seat somewhat in the nature of a ball joint. The sleeve

surrounding the rod and being a part of the nut is about 2¾ in. long, and being a close fit on the rod, keeps the nut in alignment with the rod and causes it to revolve and follow the direction taken by the rod when weaving of the beam occurs for any reason, thus eliminating strain on the rod in the threaded portion. The use of this device does not affect interchangeability of parts and there is no penalty involved for non-use in repairs.

The committee has no objection to the interchange of cars equipped with this new design of tension-rod nut.

Arrangements have been completed for inspecting and testing 100 Pennsylvania and 100 A. T. & S. F. cars equipped with Type AB brakes having new type Westinghouse and New York brake-pipe strainers, which were developed as a result of conditions found upon our last inspection which affected the charging chokes and passages because of rust and foreign matter which was not excluded sufficiently to prevent restricting the rate of normal charging of the brake system.

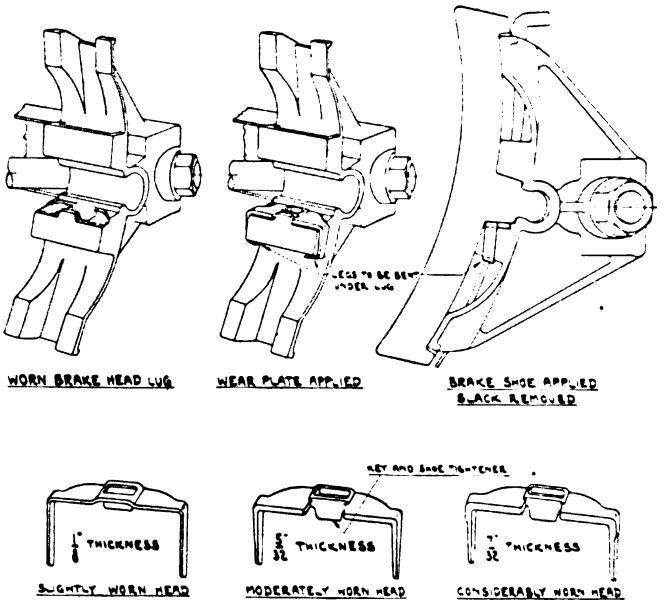
This inspection has not progressed to a conclusion, and report covering our findings will be submitted as soon as all cars are available for this investigation.

Gages for U. C. Protection Valve

In order to prolong the service life of the protection valve in the universal control valve, we recommend changing the dimension of gage No. 37016 from 1.241 in., as shown on page B-80-1935, Manual of Standard and Recommended Practice, to 1.239 in.

Temporary Repairs for Brake-Beam Heads

For the past seven or eight years, various member railroads have used a wear plate of the type shown in the accompanying



Brake head wear plate

drawing when the distance between the upper and lower brake-shoe lugs of the brake-beam head measure 2¼ in. or more at the face of the head and the head otherwise meets the A. A. R. requirements at the time periodical repairs to air brakes are made, or when cars are found in train yards with brake-head wear as described.

Many thousands of these plates have been applied to restore the lug openings to their original measurements and to provide for tightly securing the brake shoe in the brake head. These plates have rendered satisfactory service, and the approval of their general use would avoid the expense involved in removing brake beams from cars and sending them to repair shops or reclamation points for reconditioning.

We would recommend that cars carrying brake beams equipped with a device as shown in the accompanying drawing and titled "Brake-Head Wear Plate" be accepted in interchange so long as the application of such wear plate provides for reducing the opening between the brake-shoe lugs to less than 2¼ in.

Other Subjects Under Consideration

The following subjects are also being actively considered by the committee: Gages for remounted couplings, test codes for single-car test devices, standardization of No. 3 brake beam, brake-beam gages, power brakes for ultra-high-speed trains, lightweight brake beams for lightweight cars, braking ratio for passenger cars and locomotives, maintenance and inspection of brake beams and attachments, copper tubing and brass fittings for air-brake lines, and procedure for cleaning and testing Type AB brakes on repair tracks.

The report was signed by Chairman G. H. Wood, supervisor air brakes, Atchison, Topeka & Santa Fe, Topeka, Kan.; Vice-chairman W. H. Clegg, chief inspector air brake and car heating equipment, Canadian National, Montreal, Que.; T. L. Burton, air-brake engineer, New York Central, New York; R. J. Watters, general air-brake inspector, Northern Pacific, St. Paul, Minn.; C. H. Rawlings, general air-brake instructor, Denver & Rio Grande Western, Denver, Colo.; M. A. Kinney, general master mechanic, Chesapeake & Ohio, Columbus, Ohio; R. C. Burns, general foreman, Pennsylvania, Philadelphia, Pa.; L. S. Ayer, general air-brake inspector, Southern Pacific, San Francisco, Cal.; J. P. Stewart, general supervisor air brakes, Missouri Pacific, St. Louis, Mo.; R. E. Baker, general air-brake inspector, Boston & Maine, Boston, Mass.

(The report was approved and recommendations ordered submitted to letter ballot.)

Prices for Labor and Materials

In order that the rules may currently provide an equitable basis for inter-road billing, the committee has continued the work of analyzing material, labor and new equipment costs in A. A. R. Interchange Rules 101, 107, 111 and 112 of the Freight Car Code, and Rules 21 and 22 of the Passenger Car Code, with a view of determining and recommending necessary changes to be made in the next supplement to the current Code.

Rule 101

All miscellaneous material prices in Rule 101 were rechecked as of March 1, 1938, quotations from purchasing agents of the 10 selected railroads, representing 39 per cent of total freight-car ownership in the United States and Canada, indicating no changes were necessary in new or scrap prices except in the case of pipe fittings.

Due to changes in combination labor and material items in Rule 111 effective January 1, 1938, Items 38, 40, 42, 45, 46, 47, 48 and 49 of Rule 101 covering retaining valves and release valves, are modified to harmonize.

Item 49-A is relocated as new Item 82-A under list of AB type brake material and modified to cover material only, the labor charge being provided for in Item 27 of Rule 111. Former Items 58 to 76, inclusive, have been relocated as new Items 98 to 99-G, inclusive. Note following Item 57-U is relocated to follow new Item 85.

New Items 58 to 85, inclusive, have been added, covering AB type brake material.

Allowances opposite Items 116, 118 and 120 have been reduced to basis of 60 per cent instead of 75 per cent of value new for type-D coupler bodies, and those opposite Items 124 and 125 to basis of 30 per cent instead of 50 per cent of value new for former and temporary standard couplers, to agree with adjusted allowances for older types of couplers in Rule 104, as suggested by the Committee on Couplers and Draft Gears and recommended in the 1938 report of the Arbitration Committee.

The table of weights of truck spring coils is modified to include weight of the 5½-in. by 8¼-in. spring. Reference to truck-spring capacity is eliminated from this table since it is unnecessary for billing purposes.

Rule 107

Notes are added to Items 128 and 158, and the last note under Item 270 is modified, to clarify the intent.

Allowances opposite Items 260 and 261 are modified in accordance with detail time studies of these operations.

Former Items 301 to 316, inclusive, covering specified allowances for dismantling various types of cars, are eliminated; and a new Item 301, with notes, added, to establish price for dismantling all types and classes of cars on authority of owners, on a per pound price for metal contained in car. It is felt this method of charging will simplify the rule. The allowance is equitable, being based on actual time studies of the operation made by a special subcommittee on five railroads and including 29 cars of various classes and types.

Rule 111

Revision of Item 15, to provide an average charge (including both labor and material) for C. O. T. & S. of AB freight brake equipment, based on time studies conducted on six railroads in various sections of the country, is recommended. This is similar to the allowance now in the rule for C. O. T. & S. of K. type brakes; it greatly simplifies the billing and eliminates the necessity for following individual valves through the air-brake room or manufacturer's plant and holding billing until a list of the material renewed in each case is available. It will also eliminate numerous controversies arising in connection with such charges.

New Items 16 to 27, inclusive, are added to this rule, to establish definite allowances for a number of operations in connection with AB brake equipment parts, now charged on the basis of actual time. These allowances are also based on time studies of the various operations.

Interpretation No. 1 is modified to harmonize with the change in allowance in Item 3 of this rule.

Rule 112

Recommendations are made in this rule respecting reproduction pound prices of new freight-train cars of all classes, in order that Supplement of August 1, 1938, may reflect 1937 costs in lieu of figures shown in the present Code. New prices recommended are based on costs of 47,270 freight cars constructed during 1937.

As Class F cars (all-wood) were prohibited in interchange effective April 1, 1937, and the Arbitration Committee eliminated this class of car from the depreciation rate and depreciation limit tables in Rule 112 effective January 1, 1938, it is recommended that the Class F car also be eliminated from the per-pound reproduction-cost table.

Passenger Car Rules 21 and 22

Item 25-B of passenger-car Rule 21 is modified to clarify the intent with respect to prices for two-wear wrought-steel wheels. No modifications are recommended in passenger-car rule 22.

It is the intent of the Committee to investigate labor and material costs again in October and if sufficient change develops, necessary revision will be made and inserted in the Rules effective January 1, 1939.

[The changes recommended in the existing rules are shown in detail in the report.—Editor.]

The report was signed by A. E. Calkins (chairman), superintendent equipment, New York Central; H. H. Harvey (vice-chairman), general car foreman, Chicago, Burlington & Quincy; T. J. Boring, general foreman, M. C. B. Clearing House, Pennsylvania; H. H. Boyd, assistant chief motive power and rolling stock, Canadian Pacific; A. E. Smith, vice-president, Union Tank Car Company; A. H. Gaebler, superintendent car department, General American Transportation System, Inc.; P. Kass, superintendent car department, Chicago, Rock Island & Pacific; F. J. Dodds, general car inspector, Atchison, Topeka & Santa Fe; O. A. Wallace, supervisor car repairs, Atlantic Coast Line; and D. F. Nourse, A. A. R. inspector, New York, New Haven & Hartford.

The report was accepted.

Report on Tank Cars

During the year the committee considered a total of 346 dockets and applications for approval of designs of which 221 covered shipping containers of twenty classes, for application to new cars or for replacement on existing cars. Four applications covered 27 multi-unit cars to be used for the transportation of 15 Class ICC-106-A-500 one-ton containers each. Sixteen applications covered 187 new underframes and trucks for use in mounting existing tank-car tanks.

Eighty-three applications covered alterations in existing equipment consisting of application of exterior heater pipes, interior heater pipes, insulation, lining, reinforcing bands, tank stabilizers, tank shell reinforcement at dome flange and reinforcement at center sills of multi-unit tank cars, also conversion from single to two compartments, from single to three compartments, from ARA-III to ARA-III insulated, from ARA-IV to ARA-III insulated, from A.R.A.-IV to A.R.A.-III, from ICC-103 to ICC-103 insulated, from ICC-103 to ICC-103-A, from ICC-103 to ICC-103-B, from ICC-103 to ARA-203, from ICC-104 to ICC-103 insulated, and conversions for Fullers Earth service and for phosphorus service.

Classes of Shipping Containers Approved for Application to New Cars or for Replacement on Existing Cars

Class	No. of tanks
ICC-103	1,168
ICC-103-A	471
ICC-103-AL (Aluminum)	45
ICC-103-B	65
ICC-103-B-W (Fusion welded seams)	2
ICC-103-C-W (Fusion welded seams)	12
ICC-103-W (Fusion welded seams)	10
ICC-104	3
ICC-104-A	23
ICC-105-A-300	67
ICC-105-A-300-W (Fusion welded seams)	64
ICC-105-A-400-W (Fusion welded seams)	125
ICC-105-A-500	70
ICC-106-A-500	1,115
ICC-106-A-800	1
ICC-107-A****	2
AAR-201-A-35	2
AAR-201-A-35-W	17

Eighteen applications requested approval of tank-car appurtenances as follows: One anchorage for Class ICC-105-A series tank cars in chlorine service; one angle valve for propane and anhydrous ammonia service; two bottom-outlet nozzle, steam-jacketed; one bottom-outlet valve for tanks in asphalt service; one dome cover, bolted type, modified design; two dome safety platform; one dome-cover safety device; one dome cover, quick opening; one insulation; one protective housing for top unloading connections; one removable eduction tubes for Class ICC-106-A-500 containers; one sampling device; one safety valve, tanks in chlorine service; one safety valve, tanks in propane and anhydrous ammonia service; one safety vents, Class ICC-103-B tank-car tanks; one valve for Class ICC-106-A-500 containers, design modified.

Tank Cars for Dual Lading Service

The Interstate Commerce Commission, by modification, effective April 15, 1938, of second subparagraph, Par. 431(a) of their regulations for the transportation by rail of explosives and other dangerous articles in freight service permitted the use of tank cars "equipped and authorized as indicated by the name of the commodity stenciled on the tank" for additional use in transporting other commodities under requirements prescribed therein.

A total of four applications has been considered by your committee under this requirement, one covering cars for transporting propane or anhydrous ammonia and three for cars to transport anhydrous ammonia or nitrogen fertilizer solution.

Fusion-Welded Tank-Car Tanks

Since the public hearings before the Interstate Commerce Commission, at Washington, D. C., on September 5, 6 and 7, 1934, on the matter of fusion-welded tank-car tanks for the transportation of dangerous commodities the commission have authorized, by order, a total of 523 fusion-welded tanks for experimental service trials.

No general revision of the Interstate Commerce Commission specifications for tanks to be mounted on or to form part of a car has been made since 1930. Your committee is now actively engaged in revising the specifications, effective in 1931, bringing them into conformity with current demands of owners, shippers and other interested parties.

Aluminum Tanks for Transporting Dangerous Commodities

By order, the Interstate Commerce Commission has authorized the construction of 30 tank cars equipped with riveted aluminum tanks (Class ICC-103-AL) and their use in experimental trials in transporting commodities classed as dangerous by the commission's regulations.

The report was presented by Chairman G. S. Goodwin, assistant to general superintendent motive power, Chicago, Rock Island & Pacific, Chicago; Vice-chairman F. A. Isaacson, engineer car construction, Atchison, Topeka & Santa Fe, Topeka, Kan.; A. G. Trumbull, chief mechanical engineer, Chesapeake & Ohio, Cleveland, Ohio; G. McCormick, general superintendent motive power, Southern Pacific, San Francisco, Cal.; W. C. Lindner, chief car inspector, Pennsylvania, Philadelphia, Pa.; A. E. Smith, vice-president, Union Tank Car Company, Chicago; G. A. Young, head, school of mechanical engineering, Purdue University, La-Fayette, Ind.; F. Zeleny, engineer of tests, Chicago, Burlington & Quincy, Aurora, Ill.; W. C. Steffa, transportation manager, Sinclair Refining Company, New York; R. T. Baldwin, secretary, Chlorine Institute, Inc., New York; H. J. Gronemeyer, supervisor car equipment, E. I. duPont de Nemours & Company, Inc., Wilmington, Del.; R. W. Thomas, manager Philgas department, Phillips Petroleum Company, Detroit, Mich.

(*The report was approved.*)

Loading Rules

General Rules

Rule 4

Change wording of Section (c) to read:

To obtain full capacity or load weight the load should be placed in two piles over bolsters or uniformly distributed over car floor. Short material loaded between body bolster and end of car must not exceed twenty per cent of stenciled load limit. Concentrated loads 18 ft. long or less must not exceed seventy-five per cent of stenciled load limit.

Eliminate the note following Section C.

Reason—Reference to wooden cars now unnecessary.

Rule 8

Eliminate and substitute the word "Vacant" in Section (c).

Reason—Not required because wooden underframe cars are not interchangeable.

Rule 16

Add to first sentence of Section (a) "except as provided for in paragraph (f)".

Change Section G to read:

When material is of unequal lengths and overhanging one or both ends, the weight of load shall be based on the average lengths of pieces in the overhang, measured from center of truck to ends of load. When the material in the overhang is of various lengths, the allowable width shall be based on the total width of the overhang at the extreme ends. Table I is based on the end of load opposite the overhanging and being located 18 in. from the face of end sill of car. In cases where the type of brake and load permits utilizing part or all of this space, thereby, making the overhang less than specified in the tables, the width of load and the percentage of load weight may be increased in accordance with the shorter overhang.

Reason—To clarify the intent of the rule.

New Figures Proposed

New figures have been proposed, for addition to the rules, as follows:

Fig. 5—To show the length of slotted hole for center pin in center-plate backing.

Fig. 46-A—Revised method for loading light roof trusses.

Fig. 56-A—Alternate method for securing structural steel, shapes and rods with high-tension bands.

Fig. 75-A—Method of loading wire coils.

Fig. 83-A—Alternate method of using 1¼-in. instead of 2-in. high-tension bands for securing wrought-iron pipe.

Fig. 146-A—Alternate method for securing locomotive type boilers with high-tension bands.

Fig. 146-B—Alternate for securing small boilers with high-tension bands.

Revisions to Existing Figures

Fig. 6

Add note following item F to read: *For loads per sketch 2, use not less than 8 pr. of stakes, items B, and eliminate items D and F.*

Reason—By request of shippers.

Fig. 27

Sketch and specifications revised to include binder added at center to provide greater safety.

Fig. 28

Change heading to read:

Minimum requirements for securing entirely creosoted and other poles, etc.—*gondola cars.*

Change item C to read:

Number of Pieces	Description
For loads 3 ft. or less above top of car sides, 1 ea. pr. stakes.	4 strands, 2 wrappings, ⅛ in. dia. wire across top of load, twisted taut.
For loads over 3 ft. above top of car sides, 2 ea. pr. stakes.	6 strands, 3 wrappings, ⅛ in. dia. wire, halfway between top of car sides and top of load and over top load. For entirely creosoted poles use 3 items C, equally spaced. Twist taut.

Change last paragraph to read:

When ends of 2 piles are interlaced, use 6 pair of stakes for total length of load, unless interlace exceeds 36 in., when 5 pair of stakes for total length of load may be used with 1 pair at center of interlaced ends.

Reason—To provide greater safety.

Fig. 29

Sketch and specifications revised to include binder, added to provide greater safety.

Fig. 30

Sketch and specifications revised to provide greater safety.

Fig. 31

Change heading to read:

Minimum requirements for securing long poles, piling, telegraph poles, etc., excluding entirely creosoted poles, loaded on top of single loads—*flat or gondola cars.*

Reason—To indicate that this figure does not cover entirely creosoted poles.

Fig. 32

Sketch and specifications revised to cover loads overhanging at one or both ends of car, or loads on two or three cars.

Fig. 35

Change item E to read:

Number of Pieces	Description
3 per pile.	6 in. by 8 in., hardwood, length to suit. For piles 20 ft. to 30 ft. long, inclusive, the center clamps may be substituted with 2 pr. items B.

Change item G to read:

2 ea. item E. 1 in. dia. *with washers.*

Change second paragraph to read:

Items E, F, G and H are not required when *more than 3 pr. items B, C and D* are used or vice versa.

Reason—To strengthen load as per request of shippers.

Fig. 37

Sketch and specifications revised.

Reason—Item E, eliminated—not required.

FIG. 38

Sketch and specifications revised.
Reason—Item F, eliminated—not required.

FIG. 41

Change heading to read:
Minimum requirements for securing flat plates, on top of car with sides not over *48* in. high.
Reason—To make applicable to modern equipment with car sides 48 in. high.

FIG. 42

Change heading to read:
Minimum requirements for securing flat plates, on top of car with sides not over *48 in.* high.
Reason—To make applicable to modern equipment with car sides 48 in. high.

FIG. 43

Change the second note following item E to read:
Plates 24 in. wide or less, and not more than 18 in. less than inside width of car, loaded crosswise as per sketch 3, do not require bracing to prevent side shifting when the ends of alternate piles are placed against car sides.
Reason—To indicate when bracing is required to prevent side shifting.

FIG. 46

Eliminated.
Reason—Being consolidated with Fig. 47.

FIG. 47

Sketch and specifications revised.
Reason—Diameter of rods for loads weighing 30,000 lb. or less increased from ¾ in. to ⅞ in., and from ⅞ in. to 1 in. for loads weighing over 300,000 lb., and rods of 1¼ in. dia. eliminated, by request of shippers.

FIG. 48

Change item C to read:
6-in. by 8-in., hardwood. Place one bolt, ½ in. dia., crosswise, with washers, at each end to prevent splitting.
Reason—By request of shippers.
Change second sentence of item G to read:
When sliding-piece is located between end of car and body bolster, the weight on same must not exceed 20 per cent.
Reason—To eliminate reference to wooden and steel underframe cars.
Add new paragraph to read:
For flat cars add one binder to overhang, above couplers, in which case dimensions of binders may be 4 in. by 6 in., with split bolts.
Reason—To strengthen load on flat cars.

FIG. 49

Change item C to read:
6 in. by 8 in., hardwood. ½ in. dia. bolt with washers at each end to prevent splitting.
Reason—By request of shippers.
Eliminate second sentence in last paragraph reading: Load carried between bolster and end of adjacent car must not exceed 15 per cent of load weight limit, wooden underframe cars, and 20 per cent of load weight limit, steel underframe cars.
Reason—Covered in General Rule 4.

FIG. 50

Change item C to read:
6-in. by 8-in., hardwood. ½ in. dia. bolt with washers at each end to prevent splitting.
Reason—By request of shippers.
Eliminate second sentence in last paragraph reading: Load carried between bolster and end of adjacent car must not exceed 15 per cent of load weight limit, wooden underframe cars, and 20 per cent of load weight limit, steel underframe cars.
Reason—Covered in General Rule 4.

FIGS. 51 AND 51-A

Eliminate the words "and 17", from next to last paragraph.
Reason—Rule 17 has been eliminated.

FIG. 52

Change item C to read:
6-in. by 8-in., hardwood. ½ in. dia. bolt with washers at each end to prevent splitting.
Reason—By request of shippers.
Eliminate the words "and 17" from last paragraph.
Reason—Rule 17 has been eliminated.

FIG. 53

Sketch and specifications revised.
Reason—Reference to girder loading eliminated.

FIG. 54

Sketch and specifications revised.
Reason—Reference to girder loading eliminated.

FIG. 55

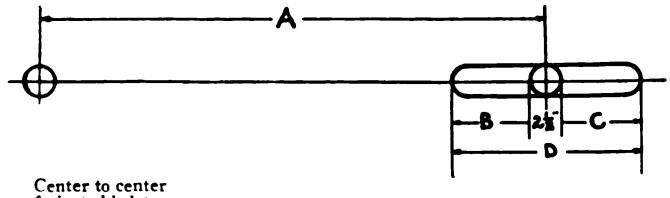
Eliminated.
Reason—Consolidated with Figs. 53 and 54.

FIG. 57

Sketch and specifications revised.
Reason—Reference to girder loading eliminated.

FIG. 62, 63, 63-A, 64, 66 and 135

Reference to New Fig. 5 included for length of slotted center pin hole.
Reason—Fig. 5 has been provided to show length of slot in center-plate backing, as it has been found that present length of slot is not adequate for safe transportation of long girders, etc.



Center to center of pivoted bolsters A	B	C	D
49 ft. to 70 ft. inc.	2 in.	1¼ in.	5¾ in.
71 ft. to 80 ft. inc.	2¼ in.	1¾ in.	7 in.
81 ft. to 90 ft. inc.	2¼ in.	2½ in.	7¾ in.
91 ft. to 100 ft. inc.	2¾ in.	3½ in.	8¾ in.
101 ft. to 110 ft. inc.	4⅛ in.	4¾ in.	11⅜ in.
111 ft. to 120 ft. inc.	4⅛ in.	6 in.	12⅜ in.

Prepare cars as per Fig. 3. Before locating center plate backing on carrying cars, push cars together to eliminate all coupler slack between cars. Center pins to be located in hole as shown in the above figure.
Dimensions of center plate backing must be not less than 3 in. × 12 in. × 5 ft. and wide enough to provide 2 in. of material beyond each end of slotted hole.

New Fig. 5—Minimum dimensions of slot in center plate backing for center pin used in connection with pivoted bolster

FIG. 77

Change heading to read:
Minimum requirements for securing sheet steel one-eighth inch thick or less in single-tiered piles, 20 in. high or less above car floor, with No. 8 gage high-tension wire, strength 2,000 lb. per strand, and with ends of load not less than 6 ft. from ends of car—flat cars.
Reason—To indicate the maximum thickness of sheets covered by this method of loading.

FIG. 78

Change heading to read:
Minimum requirements for securing sheet steel one-eighth inch thick or less, in single-tiered piles, 20 in. high or less, above car floor, with high-tension bands, and with ends of load not less than 6 ft. from ends of car—flat cars.

Reason—To indicate the maximum thickness of sheets covered by this method of loading.

New Fig. 83-A

Sketch and specifications revised.

Reason—Shippers requested alternate method of using 1¼-in. instead of 2-in. high tension bands.

Fig. 115

Change note to read:

Note: Items B to G, inclusive, may be substituted with two strands, one wrapping, ⅛ in. dia. wire in cases where load extends six inches or less above top of car sides, or ends, or when pyramided from top of car sides to not more than 18 in. at center of car and wired down so as to prevent scrap from projecting beyond car sides or ends. Wire must be spaced not more than 3 ft. apart and secured to stake pockets or car sides.

Reason—To improve the method of loading.

Alternate to Present Fig. 127

The committee has been working on a method for securing transformers on flat cars, alternate to present Fig. 127, but was unable to complete it in time for this report. Efforts, however, are being made to have it completed in time for letter ballot, a large shipper having requested that it be included in the next issue of the loading rules.

Fig. 153

Change first paragraph to read:

Anchoring the rotating portion to crawler structure with items Q, 2 at rear and 2 at front, is permissible, provided the machine is tied to car, at front and rear, with suitable rods or cables to prevent teetering. When boom is detached, items Q must be applied at rear to car body and at front to the crawler structure.

Reason—To clarify the intent of the rule.

Fig. 168-B

Eliminated.

Reason—Shippers decline to use it because it is too expensive.

Fig. 176

Change item G under "No. of Pcs." to read: 4 ea. axle.

Reason—To clarify the intent.

The report was signed by W. B. Moir (chairman), chief car inspector, Pennsylvania; E. J. Robertson (vice-chairman), superintendent car department, Minneapolis, St. Paul & Sault Ste. Marie; R. H. Dyer, general car inspector, Norfolk & Western; G. R. Lovejoy, master mechanic, Detroit Terminal; T. O. Sechrist, assistant superintendent machinery, Louisville & Nashville; C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau; H. S. Keppelman, superintendent car department, Reading; T. W. Carr, superintendent rolling stock, Pittsburgh & Lake Erie, and A. H. Keys, district master car builder, Baltimore & Ohio.

The report was approved and recommendations ordered submitted to letter ballot.

Rules for Using Liquid Petroleum Gases

The attention of your Subcommittee on Underwriters' Laboratories Tentative Outline for Inspection and Labeling of Self-Propelled Railroad Equipment Utilizing Internal Combustion Engines was brought by the Railroad Insurance Association to the necessity for specifications for the installation of containers for liquefied-petroleum-gas systems and piping or other facilities to the gas-consuming unit, including internal-combustion engines for self-propelled cars or auxiliary units, and heating for various purposes, as well as lighting.

In view of the varied interests involved a conference was held by your committee on October 26, 1937, with representatives of the following associations and companies: Underwriters' Laboratories, Inc., Railroad Insurance Association, Compressed Gas Manufacturers Association, National Bottled Gas Association, Shell Petroleum Corporation, and Phillips Petroleum Company.

During the years 1935, 1936 and 1937, the use of liquefied petroleum gases by the railroads has increased materially. Some of the typical uses of these gases on equipment are: (1) Internal-combustion-engine operation of air-conditioning equipment and electric generators; (2) switching locomotives with electric or geared drive powered by internal-combustion engines; (3) cooking in diners, cafe cars, business cars and freight cabooses; (4) gas lighting of coaches; (5) switch heating to prevent accumulation of snow and ice; (6) metal cutting and miscellaneous shop use, and (7) heating of refrigerator cars in cold weather.

Because of this widespread development it has been necessary to prepare regulations for the guidance of the railroads. These regulations are intended to govern the location, design and construction of fuel containers and other equipment necessary for the safe and efficient use of liquefied petroleum gases on railway coaches, motor cars, locomotives and other mobile equipment, and the storage and handling of these gases in cylinder quantities in railroad yards and terminals.

In the further interests of safety it is equally important that employees understand the inherent hazard of these gases, that they may be thoroughly trained in safe practice for the storage, handling and distribution of fuel containers and in the operation of liquefied petroleum gas utilization equipment.

The Interstate Commerce Commission defines a compressed gas as any material with a gage pressure exceeding 25 lb. per sq. in. at 70 deg. F., or any liquid flammable material having a vapor pressure (determined by the Reid Method) exceeding 40 lb. per sq. in., absolute, at 100 deg. F., March to October, inclusive, or exceeding 45 lb. per sq. in., absolute, at 100 deg. F., November to February, inclusive.

The composition of liquefied petroleum gases varies, but in all of the established grades the predominant compounds are propane and butane (isobutane and normal butane). Under moderate pressure these gases liquefy, but upon release of the pressure are readily converted into the gaseous phase. Advantage of this characteristic is taken by the industry, and for convenience and economy the gases are shipped and stored under pressure as liquids. When in the gaseous state these gases present a hazard comparable to any flammable natural or manufactured gas, except that being heavier than air, ventilation requires added attention.

In the customary method of utilization of liquefied petroleum gases as motor fuel, the liquid is forced by its own vapor pressure out of the fuel tank, through a liquid pressure-reducing regulator to a vaporizer or heat exchanger where it is completely vaporized. The gas then passes through either one or two stages of pressure reduction in approved regulators to reduce it to substantially atmospheric pressure, thence to the gas-air mixer or carburetor where it is mixed with the required volume of air and delivered to the intake system of the engine. Propane can be vaporized directly from the fuel tank without the use of a vaporizer except when the volume used is so great that the refrigeration caused by vaporization reduces the vapor pressure in the tank too greatly. In the latter case and with other liquefied petroleum gas products vaporization is accomplished in a vaporizer or heat exchanger usually heated by water from the engine cooling system or by hot gases from the engine exhaust. When a water-heated exchanger is used in connection with propane it is necessary to provide sufficient exchange surface to prevent freezing of water when self-vaporization of fuel occurs before circulation of water begins.

Generally no vaporizer is needed when propane in cylinders is used for small internal-combustion engines operating car air-conditioning or car electric-generating equipment nor are they needed for gas-cooking or gas-lighting installations, provided a sufficient number of containers are installed to meet the demand of the connected load.

[At this point in the report the committee submitted in detail tentative regulations for the design, construction, installation and operation of liquefied petroleum gas installations on mobile railway equipment. These regulations will be the subject of an article in a later issue.—Editor.]

The report was signed by Chairman W. E. Dunham, superintendent car department, Chicago & North Western; E. Wanamaker, electrical engineer, Chicago, Rock Island & Pacific, and W. J. Madden, assistant foreman, Pennsylvania.

(*The report was approved and ordered submitted to letter ballot for adoption as recommended practice.*)

Specifications for Materials

The committee, during the past year, reviewed all of the specifications and submitted the following revisions for consideration.

Specifications M-115-37, Boiler and Firebox Steel for Locomotives

Under Subdivision I, Manufacture, Section 2, add paragraph identified as (c), to read as follows:

(c) All plates shall be cut so that length shall extend in direction of rolling, unless otherwise agreed upon.

Specifications M-202-37, Design Test Requirements for Truck Bolsters

Revision consisting of adding specification numeral identification in Section 2. Paragraph to read:

2. Material.—Shall be one of the following, as designated, and shall conform to the latest revision of the appropriate specifications:

Cast steel ..... *(Spec. M-201)*
Structural steel ..... *(Spec. M-116)*
Forged iron ..... *(Spec. M-307)* **or**
Forged steel ..... *(Spec. M-102 and M-104)*

Specifications M-203-37, Design Test Requirements for Truck Side Frames, Cast Steel

Revision consists of adding specification numeral identification in Section 2, the section to read:

2. Material.—Shall be of cast steel in accordance with latest revision of A. A. R. Specifications M-201, Grade B.

Specifications M-205-32, Design Test Requirements for Coupler Yokes

Revision consists of adding specification numeral identification in Section 2, the section to read:

2. Material.—Shall be one of the following, as designated, and shall conform to the latest revision of the appropriate specifications:

Cast steel ..... *(Spec. M-201)*
Structural steel ..... *(Spec. M-116)*
Forged iron ..... *(Spec. M-307)* **or**
Forged steel ..... *(Spec. M-102 and M-104)*

Specifications M-306-37, Welded Wrought Iron Pipe

Corrections and additions have been made in Sections 1, 2, 3, 5, 6, 12 and 17, and in Table I.

Specifications M-501-34, Lined Journal Bearings

Section 8. Gaging, to be changed to read as follows:

8. Gaging.—All bearings shall conform to the latest standards of the Mechanical Division of the Association of American Railroads, with respect to form, dimensions and variations therefrom, *as shown on sheets B-21 and D-23 of the Manual of Standards and Recommended Practice.*

Changes in Specifications for Rubber Products

Each of the specifications pertaining to rubber has been revised extensively as to form and substance, and recommended specifications were included as part of the report. Those specifications are:

Specification No.	Title
M-601-38	Hose, air brake and train air signal
M-602-38	Gaskets, air brake hose
M-603-38	Hose, air, gas and oxygen, wrapped and braided
M-604-38	Hose, cold water, wrapped and braided
M-605-38	Hose, steam and hot water
M-606-38	Hose, tender tank
M-607-38	Rubber goods, general instructions on standard methods of test for

Specifications M-904-36, Reclaimed Car Oil

This specification has been reviewed by a joint sub-committee representing the Specifications and Lubrication Committees.

The joint sub-committee's report and recommendations applying to specification M-904-36 were covered in their report of May 12, 1938, addressed jointly to the chairmen of the Specifications and Lubrications Committees. An excerpt from this report follows:

"The Joint Sub-Committee recognized the fact that the information made available through the 1936-38 survey divides the car oils now reclaimed by the railroads in the country into four general classes:

"(1)—Those employing a washing process and treatment with caustic and separation of the dirt and impurities by settling.

"(2)—Those employing a process of distillation.

"(3)—Those employing a centrifuge or mechanical means for the removal of the dirt, followed by filtration and settling.

"(4)—Those employing filtration and settling without special chemical treatment or mechanical apparatus.

"In redrafting revised Specification M-904-38 and new Specification M-910-38 at this meeting, the joint sub-committee took cognizance of the fact that there is a clear differentiation between the degree of cleanliness of the renovated materials by the processes now in general use as indicated by the values of 'tarry matter' and 'insoluble impurities' in the case of the oils, and of the 'total impurities (incl. tarry matter),' in the case of the wastes and packings. It is apparent that it would be possible to set lower limits on the permissible impurities in car oils renovated by either the chemically treated or the distillation processes than with the centrifuged oils, and that a specification to include the oils in the fourth class (filtered and settled) would be of little or no value.

"It is further apparent that the reason for the relatively higher impurities in the oils renovated by centrifuging is due to the higher fine dirt content in this class of renovated oil. After full discussion, the joint sub-committee was of the opinion that the presence of fine dirt in the oil is detrimental and that its permissible quantity, therefore, should be limited. It was the consensus of opinion at the meeting that the presence of colloidal material in an oil *used with waste* for journal lubrication is objectionable for the reason that the finely divided material gets into the fibres of the waste and retards capillary feeding of the oil to the journal.

"It is not the desire or the intent of the joint sub-committee, however, to set the limits for the allowable impurities in acceptable renovated oil so low that they may not be realized with present mechanical equipment (centrifugal separators, etc.) now available and owned by a number of railroads. It is felt that the limits set can be met with mechanical equipment available when properly operated and controlled."

The recommendations of the joint sub-committee and the proposed specification M-904-36 were reviewed by the Committee on Specifications for Materials at a meeting held May 24 and 25, 1938. Certain changes in wording were approved by the committee as a whole, and the proposed specifications were changed accordingly by the joint sub-committee chairman. The proposed specification, M-904-38, was submitted with the report.

The discussion in the meeting of the Specifications Committee developed a minority opposition to full approval of the proposed specifications. This minority, representing railroads using mechanical process of renovating, were not agreeable to acceptance of limits set up for items (4) tarry matter, and (5) insoluble impurities (dirt), shown in Section 5 of the specifications.

A discussion of the points in question in this specification, is given in the following excerpt from the minutes of the Specification Committee:

"Discussion developed that all were in agreement with the specification, except in respect to limits shown for items (3) water; (4) tarry matter; (5) insoluble impurities (dirt), as set up in Paragraph 5, Section II—Properties and Tests. Mr. Jackson explained to the committee that the limits as set up in this specification were based on results of tests on samples of reclaimed packing and oil submitted by various members and, while it was true the results of certain samples from certain roads did not comply with the limits set up, his sub-committee felt that oil conforming to the proposed specification requirements represented an oil of desirable properties. The discussion brought out further that, apparently to meet these requirements in renovating the oil, chemical treatment would be involved. Messrs. Zeleny and Staib cited the results of centrifuging, which would not conform to the proposed limits for tarry matter and insoluble impurities, and they were in doubt as to the necessity for such low limits for these two items. Mr. Chapman advised

that the Santa Fe's experience in mechanically renovating the oil was in accordance with that reported by Mr. Zeleny.

"The discussion ensuing brought out there was general agreement that fewer hot boxes apparently occurred in connection with the use of renovated oil and packing than in the use of new oil and packing—this, in particular, in cases of new brass and journal; one explanation being that the insoluble impurities acted as a polishing and burnishing agent, bringing about satisfactory conditions in respect to avoiding hot boxes. However, there was not unanimous agreement, assuming the above took place, that undue wear would not occur with continued use of the same renovated waste and oil. Messrs. Staib and Zeleny stated it was their opinion the chief benefit from renovated waste and oil was largely due to freeing and fluffing up the waste proper and removing the coarser particles from the oil.

"Another point emphasized on the part of Mr. Zeleny was the fact there is more oil lost due to using chemical means of renovating than in renovation involving mechanical methods, it being reported that, in using chemical methods, the loss was over 15 per cent more than when renovated by mechanical means, namely, centrifuging. It was also brought forth that there was a higher cost per gallon in case of renovation involving chemical treatment as compared with mechanical, but no one present had actual figures available.

"Mr. Bryant brought up the question as to the propriety of requiring such a low content for tarry matter and insoluble impurities in the new car oil specification, namely, maximum 0.10 per cent for each item, if a higher content of these two items was to be permitted in reclaimed oil, and that, if these limits were broadened in case of the new oil, undoubtedly it could be purchased at a cheaper price. To this, Mr. Zeleny replied that it costs very little more for the oil refiner working with crude oil to keep the tarry matter and insoluble impurities to the low figure, whereas it is rather expensive to do the same with used oil, and such expense is not warranted.

"Mr. Jones suggested that valuable information could possibly be obtained by a study of results of tests on reclaimed and new oil under the same conditions at the Indianapolis testing plant. it being his understanding that some tests of this character had already been carried out."

Final recommendations of the Specification Committee are that the present specification be continued in effect, and that the proposed specification M-904 be circularized among the members of the Association as information, with the request that study be given the application of the proposed requirements during the coming year; also that the Lubrication Committee be notified of this proposal, and later arrangements be made for a joint meeting to discuss the matter as a whole and attempt to reconcile the differences involved.

Proposed Specifications M-910-38. Renovated Journal-Box Waste and Packing

This specification was covered in the report of May 12, 1938, of the joint sub-committee on Specifications for Lubrication Materials, and an excerpt from this report is given above.

The proposed specification is intended to replace requirements for renovated packing, included as part of Rule 66, in the Code of Rules Governing the Condition of, and Repairs to Freight and Passenger Cars for Interchange of Traffic, the requirements in Rule 66 having been drafted in the Association standard specification form. The proposed specification M-910-38 was included as part of this report.

In case of adoption of Specification M-910-38, revision should be made in Sections 4 to 8. inclusive, of Rule 66, page 127, 1937 Revised Code of Rules. A proposed draft of such changes was included in the report. Since methods of analysis are made part of the new Specification M-910-38, Methods for Analysis of Reclaimed Waste, Section L of the Manual, page L 35-B, 1937, should be withdrawn, if and when Specification M-910-38 is adopted.

The Committee on Specifications for Materials has considered this new specification, M-910-38, and other recommendations pertaining thereto, and this Committee's recommendation is that the present requirements be maintained and that this proposed specification also be circularized among the members of the Association as information, with request that study be given the application of the proposed specification requirements during the coming year; also the Lubrication Committee to be notified of this proposal, and later arrangements be made for a joint meeting to discuss the matter as a whole, and attempt to reconcile any differences involved.

Specification for Brushes

The Purchases and Stores Division has suggested the desirability of developing uniform specifications for brushes. A subcommittee is now working on this matter.

Recommendations

The committee recommended that the above revisions in specifications, with the exception of those outlined in the case of specifications for lubrication materials, be approved for submission to letter ballot.

The report was signed by T. D. Sedwick (chairman), engineer of tests, Chicago, Rock Island & Pacific; E. E. Chapman (vice-chairman), mechanical assistant, Atchison, Topeka & Santa Fe; F. Zeleny, engineer of tests, Chicago, Burlington & Quincy; H. G. Burnham, engineer of tests, Northern Pacific; C. B. Bryant, engineer of tests, Southern; H. G. Miller, engineer of tests, Chicago, Milwaukee, St. Paul & Pacific; H. P. Hass, engineer of tests, New York, New Haven & Hartford; J. R. Jackson, engineer of tests, Missouri Pacific; J. W. Hergenhan, assistant engineer, test department, New York Central, and L. B. Jones, engineer of tests, Pennsylvania.

The report was approved and recommendations of the committee ordered submitted to letter ballot.

Report of Arbitration Committee

With the approval of the Operating-Transportation Division, no extension in effective date beyond January 1, 1939, is recommended for requirement in Paragraph (a-8) of Rule 3, prohibiting acceptance of cars in interchange bearing advertisements of any shipper, consignee or product.

With the approval of the General Committee and the Committee on Tank Cars, the members and all tank-car owners were notified on November 22, 1937, that effective date of Paragraph (t-8) of Rule 3, prohibiting the acceptance in interchange of tank cars having head block-anchorage on and after January 1, 1939, would not be further extended. Your committee so recommends.

The Committee on Couplers and Draft Gears, in its report last year, recommended that requirement be included in Rule 3 to prohibit the use of all 5-in. by 5-in. and all former standard 5-in. by 7-in. shank couplers (except type D), effective January 1, 1942, in order to reduce the number of pull-outs and to gain the advantage of the increased strength of the standard coupler. Your committee concurs and recommends such requirements to be incorporated in Section (c) of the rule.

A time limit (January 1, 1943) is recommended for inclusion in Paragraph (t-10) of Rule 3, within which all tank cars requiring metal placard holders must be so equipped.

Modification of Rules 3, 18 and 104 is recommended in connection with adoption of specification for secondhand couplers by letter ballot last year, which are in accord with suggestions contained in the 1937 report of the Committee on Couplers and Draft Gears. Upon recommendation by the same committee, a further revision of Rule 18 is proposed, extending the present 6½-in. condemning limit for horizontally inclined cracks in knuckle wall back of knuckle tail, to 7½ in., with prohibition that coupler bodies so condemned must not be reclaimed by welding.

A car owner desiring to effect betterments or change the standard of individual parts of his cars, such as wheels, brake beams, etc., is confronted with the problem of removing serviceable parts for the purpose of making the new application. A new paragraph is recommended under Rule 16, to permit stenciling of cars for the new standard prior to application, so that during the transition period foreign lines may renew in kind or substitute the new standard as the individual parts become defective.

Another economy measure is recommended in Rule 17, to permit the substitution of one type of non-approved draft gear

for another type of non-approved gear, as correct repairs, providing the gear applied conforms with the one removed as to sill spacing and coupler pocket limits.

Due to a number of accidents caused by failure of old L- and T-section cast-steel side frames, with the concurrence of the General Committee and Committee on Car Construction, revision of Rules 3, 19 and 23 have been recommended for submission to letter ballot, to prohibit welding of any description on such side frames or the application of such welded side frames to foreign cars.

All recommendations for changes in the Rules of Interchange submitted by members, railroad clubs, private car owners, etc., have been carefully considered by the committee and, where approved, changes have been recommended. The detail recommendations are as follows:

Freight-Car Rules

Rule 2

The committee recommends that third paragraph of Section (b) of this rule be modified as follows:

Proposed form—*Any* leaky tank car, *regardless of commodity carried,* shall have stenciled on both sides, in letters three inches in size, adjacent to the car number, the words "Leaky tank. Do not load until repaired," (etc.—no other changes).

Reason—To clarify the intent that this requirement applies to all classes of leaky tank cars.

Rule 3

The committee recommends that the effective dates for various requirements in the present rule, as listed below, now set at January 1, 1939, be extended to January 1, 1940:

Section (b), Paragraph (7)—Metal badge plate showing dimensions of brake levers.

Section (b), Paragraph (8)—Bottom-rod and brake-beam safety supports.

Section (b), Paragraph (9)—Braking power

Section (r), Paragraph (3)—Hatch covers to be secured by hinges.

Also, that the effective date of Paragraph (17) of Section (t) of this rule, requiring that plugs in tanks of tank cars must be of the solid type, now set at August 1, 1938, be extended to August 1, 1939, with proviso that no further extension beyond the latter date will be granted.

Reason—The present situation justifies these extensions. The requirement for solid type plugs in tanks of tank cars was incorporated in the 1938 Code as a safety measure, to comply with revised I.C.C. Specification 103, and extension of effective date beyond August 1, 1939, would not be justified.

The committee recommends that no further extension beyond January 1, 1939, be granted for effective date of requirement appearing in Paragraph (8) of Section (a) of this rule, prohibiting the acceptance of cars in interchange bearing advertisements of any shipper, consignee or product.

Reason—Sufficient time has elapsed to permit compliance with this requirement. This recommendation has the approval of the Operating-Transportation Division.

The committee recommends that no further extension beyond January 1, 1939, be granted for effective date of Paragraph (8) of Section (t) of this rule, prohibiting the acceptance in interchange of tank cars having head-block anchorage.

Reason—This requirement has been in the rules for a number of years and sufficient time has elapsed to permit compliance therewith and that no further extension of effective date is justified.

The committee recommends that second paragraph of Section (a) of this rule be modified and a new note added, as follows:

Proposed Form—(a-2) Air brakes, location of retaining valves in accordance with A.A.R. Standard, required on all cars built new or rebuilt on or after August 1, 1933. *In interchange.*

Note—It is recommended that when cars built new or rebuilt prior to August 1, 1933, receive Class I general repairs, retaining valves be located in accordance with A.A.R. Standard.

Reason—Sufficient time has elapsed to make this provision a general interchange requirement. Note added to expedite the use of the standard location on cars built prior to August 1, 1933.

The committee recommends that third paragraph of Section (a) of this rule be modified as follows:

Proposed Form—(a-3) Air brakes, including centrifugal dirt collector, in addition to above details, required on all cars built new or rebuilt on or after August 1, 1929. *In interchange.*

Reason—Sufficient time has elapsed to make this provision a general interchange requirement.

The committee recommends that fifth paragraph of Section (a) of this rule be eliminated.

Reason—Rules 19 and 60 cover.

The committee recommends that fourth paragraph of Section (b) of this rule be modified as follows:

Proposed Form—(b-4) Brake beams on all cars built new on or after September 1, 1909, and on all cars rebuilt on or after July 1, 1928, must be hung from the trucks. *In interchange.*

Reason—Sufficient time has elapsed to make this provision a general interchange requirement.

The committee recommends that fifth paragraph of Section (b) of this rule be modified as follows:

Proposed Form—(b-5) Brake-beam hangers and brake-beam hanger pins conforming to A.A.R. Recommended Practice, or equivalent in strength, required on all cars built new or rebuilt on or after January 1, 1930. *In interchange.*

Reason—Sufficient time has elapsed to make this provision a general interchange requirement.

The committee recommends that seventh paragraph of Section (b) of this rule be modified as follows:

Proposed Form—(b-7) Brake levers: Metal badge plate meeting A.A.R. requirements and fastened to underframe in an accessible location, *preferably near air-brake cylinder and on the same side of car,* showing dimensions of brake levers standard to car, required on all cars built new or rebuilt on or after August 1, 1929. Effective January 1, *1940,* the foregoing requirement will also apply to all cars. From owners.

Reason—To facilitate checking of rods and levers.

The committee recommends that new eleventh and twelfth paragraphs be added to Section (c) of this rule and included in the next supplement, to read as follows:

Proposed Form—(c-11) *Couplers, former standard or temporary standard having 5-in. by 5-in. shanks, prohibited, effective January 1, 1940, on all cars. From owners.*

(c-12) *Couplers, former standard (except type D) or temporary standard having 5-in. by 7-in. shanks, prohibited, effective January 1, 1942, on all cars. From owners.*

Reason—As recommended by the Committee on Couplers and Draft Gears.

The committee recommends that first and second paragraphs of Section (f) of this rule be combined and modified to read as follows:

Proposed Form—(f-1) Flat cars must be equipped with stake pockets 4 in. wide by 5 in. deep and have the side stake pockets spaced minimum 2 ft. and maximum 4 ft. *In interchange.*

Note.—A tolerance of ¼ in. in either dimension of the stake pocket is permissible on flat cars built prior to July 1, 1928.

(f-2) Vacant.

Reason—To shorten and simplify the rule, as dates are now unnecessary. Sufficient time has elapsed to make this provision a general interchange requirement.

The committee recommends that first paragraph of Section (h) of this rule be modified as follows:

Proposed Form—(h-1) Handbrake arrangement must be efficient on all cars. On all cars built new or rebuilt *between* March 1, 1925, *and January 1, 1937,* the braking power shall conform to the standard adopted in 1924, *or car equipped with geared hand brake complying with the requirements of the A.A.R. Specifications for Geared Hand Brakes.* In interchange.

Reason—To eliminate confliction with Paragraph (h-3).

The committee recommends that second paragraph of Section (j) of this rule be eliminated in the next supplement.

Reason—As directed by the General Committee.

The committee recommends the addition of a note to fourth paragraph of Section (r) of this rule, as follows:

Proposed Form—(r-4) Refrigerator cars, ventilated type, built new or rebuilt on or after January 1, 1935, must have hatch plugs secured by hinges. From owners.

Note.—It is recommended that when ventilated type refrigerator cars built new or rebuilt prior to January 1, 1935, receive Class I general repairs, hatch plugs be secured by hinges.

Reason—To expedite the use of hinged hatch plugs on cars built prior to January 1, 1935.

The committee recommends the addition of a note to fifth paragraph of Section (r) of this rule, as follows:

Proposed Form—(r-5) Receptacle for accommodation of defect, information and joint evidence cards, in accordance with A.A.R. Recommended Practice Specification, required on all cars built new or rebuilt on or after January 1, 1937. From owners.

Note—It is recommended that when cars built new or rebuilt prior to January 1, 1937, receive Class I general repairs, defect card receptacle as described above be applied.

Reason—To expedite the use of defect-card receptacles on cars built prior to January 1, 1937.

The committee recommends that next to last sentence in third paragraph of Section (s) of this rule, reading *"Cars built prior to 1895 may be stenciled 'built prior to 1895' or bear badge plate giving this information,"* be eliminated.

Reason—It is conservative to conclude there are no cars in interchange service built prior to 1895.

The committee recommends that third paragraph of Section (t) of this rule be modified, effective August 1, 1938, as follows:

Proposed Form—(t-3) Truck side frames, cast-steel, secondhand, must not be substituted for any other side frames (cast-steel, pressed or structural steel or arch bar type) unless entirely free from cracks, fractures, excessive wear, excessive corrosion, or porosity, or welds not performed and marked strictly in accordance with Rule 23. Secondhand side frames of older designs, such as those having T- or L-section compression or tension members, must be confined to owner's equipment and then only when such frames have been removed from same owner's equipment, or for replacements in kind on foreign cars, *and providing further that such truck frames have not been welded.*

Reason—To prohibit application of welded L- and T-types of side frames, as a safety measure, as recommended by the General and Car Construction Committees.

The committee recommends that tenth paragraph of Section (t) of this rule be modified as follows:

Proposed Form—(t-10) Tank cars: Permanent metal holders designed to provide for secure attachment, easy application, removal, or reversal of the placards prescribed by the Interstate Commerce Commission Regulations for application to tank cars, required on all new cars, on new underframes to which tanks are applied, *on* all cars receiving general repairs on or after January 1, 1932, *and on all cars after January 1, 1943,* except cars used exclusively for the transportation of non-inflammable, non-corrosive, non-poisonous and non-dangerous commodities for which the I.C.C. Regulations do not require placards. From owners.

Reason—A reasonable time limit should be established within which all tank cars requiring metal placard holders must be so equipped.

The committee recommends that second paragraph of Section (u) of this rule be modified as follows:

Proposed Form—(u-2) Underframe, etc.: No car of all-wood construction (now defined as Class F under Rule 112) will be accepted. *In interchange.*

Reason—Sufficient time has elapsed to make this provision a general interchange requirement.

Rule 4

The committee recommends that present note following Section (d) of this rule be modified and a new second note added, effective August 1, 1938, as follows:

Proposed Form—(d) Other house cars—When sheathing is split or broken, or when raked into tongue.

Note *1*—It is understood that *adjoining* raked sheathing if not split or broken will not be cardable unless raked into tongue, except that on refrigerator cars sheathing raked to bottom of bead *but not into tongue* will also be cardable *if it adjoins sheathing raked into tongue, broken or split.*

Note 2—Special type hopper cars having permanent fixed roofs (A.A.R. Class LO) shall be considered as house cars in so far as defect carding under this rule is concerned.

Reason—To more clearly define cardable raked wood sheathing and specifically classify the Class LO hopper car for defect carding purposes.

Rule 5

The committee recommends that second paragraph of this rule be modified, effective August 1, 1938, as follows:

Proposed Form—To justify bill, repairs authorized by defect card must be made within two years from date of first receipt of car on home line, except wrong repairs, which must be corrected within nine months from date of first receipt of car on home line. However, if wrong repairs of brake hangers, bolts in place of rivets, or wrong size bolts or pins, are not corrected within nine months from date of first receipt of car on home line, *or not corrected on any line* within one year from date of such wrong repairs, *counterbill* for correcting same is prohibited.

Reason—To clarify the intent that the requirement applies to correction of wrong repairs by foreign lines as well as by car owner. Car owner should absorb expense of correction after these details have given the specified length of service.

Rule 7

The committee recommends that fourth paragraph of Section (2) of this rule be modified to read as follows:

The actual weight of forgings, structural or pressed-steel shapes and weight and kind of castings must be shown on original record in space provided, except where weight of same is accurately determined by definite description or *where arbitrary weight is specified in Rule 101 tables.*

Reason—Unnecessary to record actual weights in such cases.

Rule 9

The committee recommends that sixth item in this rule be modified as follows:

Proposed Form—Brake shoe keys, applied.—*"K-34" (indicating 1934 A.A.R. Standard)* must be shown to justify charge.

Reason—To simplify the writing of billing repair cards.

Rule 16

The committee recommends that a new third paragraph be added to this rule (present third paragraph to be relocated as new fourth paragraph), to read as follows:

When effecting betterments or in application of new standards, a car owner may stencil car "New Std." (new standard) for any part of car (such as wheels, brake beams, etc.) while making partial change or without making any change. During the transition period handling line has the option of applying parts in kind or substituting the new standard. However, when such new standard details are removed account defective, they must be renewed in kind or with permissible substitutes.

Reason—To permit application of betterments or new standards as individual parts become defective.

Rule 17

The committee recommends that first paragraph of Section (c) of this rule be modified as follows:

Proposed Form—(c-1) In replacing couplers, 9⅛-in. butt may be substituted for 6½-in. butt when used with A.A.R. standard yoke in substitution for non-A.A.R. standard yoke.

Reason—Present wording technically prohibits substitutions which Section (c-2) permits as correct.

The committee recommends that fourth paragraph of Section (c) of this rule be modified and Interpretation No. 24 eliminated, as follows:

Proposed Form—(c-4) Equipment markings (for couplers, draft gears, etc.) are not required; however, the rules do not prohibit application of such markings by car owner. If car bears previous markings for couplers, in the event of first application of D or E type coupler; *or if A.A.R. approved draft gear is applied in place of non-approved or obsolete type of draft gear, and car bears previous markings for latter gears;* such markings must be changed to correspond with coupler *or draft gear* applied (for the particular end, A or B, or both ends, as the case may be) for which a charge of ½ hour may be made. In event of failure of repairing line to correct markings under such circumstances, defect card shall be issued for ½ hour labor to cover.

(Inter. 24) Vacant.

Reason—To protect car owner in such cases.

The committee recommends that Section (d) of this rule be modified as follows:

Proposed Form—(d) Bolts substituted for rivets, where rivets are the standard of the car, are considered as improper repairs, except where used in securing ladders, ladder treads, handholds, sill steps and uncoupling-lever brackets, exclusive of the tank, or metal jacket on tank, of tank cars, also for securing *coupler and draft gear* supports on tank cars; bolts should not be used for securing safety appliances on the tank or metal jacket of tank. (Etc., no other change).

Reason—To clarify the intent.

The committee recommends that a new fifth note be added to Section (e) of this rule and included in the next supplement, to read as follows:

Note 5—In the absence of stenciling to indicate type of brake beam standard to car, the majority class of beams under car will be considered as the standard to the car, or if two beams under car are of one capacity and two of another capacity, the heavier type beam will be considered as the standard to the car.

Reason—As a guide to repairing line when renewing brake beams.

The committee recommends that a new sixth note be added to Section (e) of this rule and included in the next supplement, to read as follows:

Note 6—Brake beams having more than one class number cast on strut shall be classified under the lowest class marking for charge and credit purposes.

Reason—Conflicting class number markings on brake beams are not contemplated under the A.A.R. specifications.

The committee recommends that fifth paragraph of Section (i) of this rule be modified as follows:

Proposed Form—(i-5) Where one type of non-approved friction draft gear is substituted for another type of non-approved gear, defect card *is not required if the gear applied conforms to the one removed as to sill spacing and coupler-pocket limits; but if it does not so conform, defect card must be issued for labor and material of correcting.*

Reason—It appears to be unnecessary labor and expense to remove one type of serviceable non-approved draft gear in order to replace it with another non-approved type, where sill spacing and coupler pocket limits properly conform.

The committee recommends that Section (k) of this rule be modified, effective August 1, 1938, as follows:

Proposed Form—(k) Extra heavy pipe fittings may be substituted for single-weight type, or vice versa, as correct repairs, and charge based on type of fittings applied, *except for hand rails on tank cars where charge must be confined to single-weight pipe and pipe fittings if standard to car.*

Reason—It is felt that single-weight pipe and fittings for hand rails on tank cars are a proper exception to this requirement.

Rule 18

The committee recommends that this rule be modified, effective August 1, 1938, to read as follows (bracketed "Owner Responsible"):

Rule 18. *Gage Limits For and Methods of Gaging Couplers.*

(a) *Worn Limit—Repairs (Without Removing Coupler From Car).*

(1) Couplers, types D and E, with distance between point of knuckle and guard arm exceeding 5 5/16 in. as measured by gage (Fig. *A*, present Rule 18), must have the defective part or parts renewed to bring coupler within *required* gage *of 5⅛ in. as measured by gage (Fig. B, present Rule 18). If coupler is out of gage. the body must not be renewed unless the application of secondhand, reconditioned or new knuckle, lock and pin, any or all, will not bring it within the required gage of 5⅛ in.*

(2) Couplers, other than types D and E (M. C. B.-1904 contour), with distance between point of knuckle and guard arm exceeding 5⅛ in., measured perpendicularly to guard arm (Fig. *B, present Rule 18*), must have the defective part or parts renewed to bring coupler within *required* gage *of 5⅛ in.*

Note.—The 5⅛-in. limit referred to should not be confused with the 4⅞-in. limit applicable to reclamation of knuckles as covered on pages 479-506 of the 1932 Mechanical Division Proceedings and referred to in Rule 23.

(b) *Application—Secondhand or Reconditioned Couplers.*

(1) *Coupler bodies, types D and E, secondhand or reconditioned, whether applied separately or as part of a complete secondhand coupler. regardless of any new, reused, reconditioned, or other secondhand parts (knuckle, lock and pin, any or all)*: Distance from point of knuckle to guard arm must not exceed 5 in. *as measured by gage.* [Fig. B, present Rule 18, Fig. 1 in this report.—Editor.]

(2) In the application of secondhand or reconditioned coupler bodies or complete coupler, the shank shall be not less than 21 in. in length from striking horn to crest of worn surface of butt, nor less than 3⅞ in. from pulling (rear) surface of horizontal key slot to crest of worn surface of butt, established with parallel

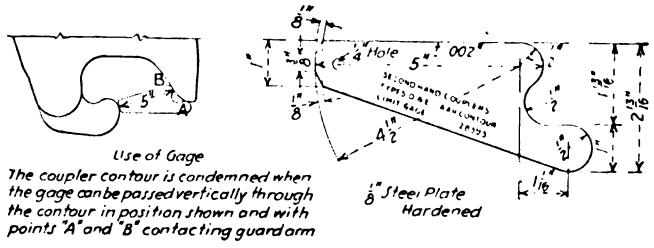


Fig. 1—Gage for measuring distance from point of knuckle to guard arm

straight edges; otherwise, such body shall be charged at scrap value. (See Fig. *D, present Rule 18.*) Coupler bodies having such minimum dimensions shall not be removed from cars for these defects alone, but if removed for other reasons and are otherwise in serviceable condition same shall be credited at secondhand value, with no allowance for expense of reclamation.

(c) *Coupler Bodies—Removal from Foreign Cars.*

Coupler bodies. Types D and E, with cracks in knuckle side wall back of knuckle tail, shall not be removed from foreign cars, unless

(1) Such crack extends beyond an area 3 in. above and 3 in. below the horizontal center line of knuckle side wall and *7½* in. back of front edge of knuckle side wall. *When crack extends beyond this area, the coupler body is condemned and must not be reclaimed by welding.* [This area is shown shaded in Fig. C of the Report on Couplers and Draft Gears.—Editor.]

(2) Section is broken out within this prescribed area whose greatest dimension exceeds three inches.

Reason—As recommended by the Committee on Couplers and Draft Gears and to harmonize with Specification for Secondhand Couplers adopted by letter ballot.

Rule 19

The committee recommends that item reading *"Pressed steel journal boxes, except when replaced in kind"*, be eliminated from this rule (which specifies material that must not be used in making repairs to foreign cars), effective August 1, 1938.

Reason—To conform with change in Paragraph (j-2) of Rule 3.

The committee recommends that a new item be added to this rule, effective August 1, 1938, to read as follows:

Cast-steel truck side frames having 'T'- or 'L'-section compression or tension members, which have been welded.

Reason—To prohibit the application of such welded side frames to foreign cars, as recommended by the General and Car Construction Committees.

The committee recommends that a new item be added to this rule, effective August 1, 1938, to read as follows:

Cast-iron wheels below nominal weight or having no cast weight.

Reason—To be consistent with other prohibitions and harmonize with Rule 83.

Rule 22

The committee recommends that sentence *"Draft timbers must not be spliced"*, be eliminated from first paragraph of this rule, account obsolete construction.

Rule 23

The committee recommends the addition of a new item to Section II of this rule, which is headed "Welding cracks or fractures (by autogenous or other method) will not be permitted on the following", effective August 1, 1938, to read as follows:

Cast-steel truck side frames having 'T'- or 'L'-section compression or tension members.

The committee recommends modification of seventh item and the addition of a new eleventh item under Section III of this rule, which is headed "Building up worn surfaces will be permissible on the following", effective August 1, 1938, as follows:

Proposed Form—†Truck sides, bolsters and column castings, *other than truck sides having T- or L-section compression or tension members.*

No welding of any kind, or building up of worn surfaces, is permitted on cast-steel truck side frames having T- or L-section compression or tension members.

The committee recommends modification of second item under Section IV of this rule, which is headed "Welding cracks or fractures will be permitted on the following", effective August 1, 1938, as follows:

Proposed Form—*Cast-steel truck sides, bolsters and transoms, *other than truck sides having T- or L-section compression or tension members.*

Reason—To prohibit welding of L- and T-types of side frames, as a safety measure, as recommended by the General and Car Construction Committees.

Note—Figure 5 of this rule, illustrating welds made in journal box of 'T'-section truck side frame, will be revised to show the 'U'-section side frame.

Rule 32

The committee recommends that a new last paragraph be added to this rule, effective August 1, 1938, to read as follows:

11. Damage to containers on container cars will be subject to the same rules as the carrying car where damage occurs at same time and is associated with handling- or delivering-line damage to the car. However, containers missing from cars in interchange are not cardable. In the case of exterior fire damage to a container where no evidence of same appears on the car, if handling line has knowledge of same occurring while in its possession, it should assume responsibility.

Reason—To provide protection for containers of container cars.

Rule 49

The committee recommends that last sentence of Paragraph (a) of this rule be modified as follows:

Proposed Form—Where receptacle is used, same should be in accordance with A. A. R. Recommended Practice specification, applied one per car, preferably located as follows, or *as near center of car as possible but not more than 24 in. from side sill, to provide easy access and conserve time in transportation yards: However, in no case should it be located* more than 5 ft. 6 in. from top of rail.

Reason—To provide for more uniform location of receptacle.

The committee recommends that note following third paragraph of Section (a) of this rule be modified as follows:

Proposed Form—Note—Suitable receptacle referred to above may not be *initially* applied to *or relocated on* foreign cars except with consent of *car* owner.

Reason—To clarify the intent and authorize renewal in kind where standard to car.

The committee recommends that Paragraph (c) of this rule be modified as follows:

Proposed Form—(c) All-steel and steel sheathed refrigerator cars not equipped with cardboards for special explosive and other placards, as required by the I. C. C. Same to be located on side doors and both ends of car. *This requirement also applies to ends of box and refrigerator cars having metal ends and wooden sides.* (On refrigerator cars, they shall be located adjacent to side doors but must not be concealed when doors are in open position.) Size not to be less than 16 by 24 in.

Reason—As required by the I. C. C. Regulations when such cars are used for the transportation of explosives and other dangerous articles.

Rule 59

The committee recommends that last paragraph of this rule be modified by the addition of italicized portion below, and new interpretation added, to read as follows:

Missing steam-heat hose or air signal hose, complete, *also missing end steam valves and metallic steam connectors,* where cars are stenciled that they are so equipped.

(Inter. 3) Q.—Where elbow or other pipe fitting is used in place of the end steam valve (on car stenciled for the latter), is this a delivering line defect in interchange on basis of missing end steam valve, or is it considered as wrong repairs for which only the road applying is responsible to car owner?

A.—In such case it should be considered as delivering line defect in interchange on basis of missing end steam valve.

Reason—To protect car owner where cars are stenciled for these items.

Rule 64

The committee recommends that note following this rule be modified in the next supplement, as follows:

Proposed Form—Note—It will be understood that the above provision also applies when such bolts are renewed. *Joint evidence as per Rule 12 must be used to establish claim of wrong repairs.*

Reason—To clarify the intent as to handling of such cases.

Rule 76

The committee recommends that this rule be modified to read as follows, changes from the present rule being italicized:

Rule 76. Tread worn hollow—cast-iron and *one-wear* cast-steel wheels: If the tread is worn so that projection on under side of gage does not come in contact with tread of wheel (see Fig. 4-D). See paragraph 110 and Fig. 92 in Wheel and Axle Manual.

Tread worn hollow—wrought-steel *and multiple-wear cast-steel wheels:* If height of flange is 1½ in. or over, as measured with standard steel-wheel gage (see Fig. 128 in Wheel and Axle Manual), or approved equivalent.

Reason—Gage shown in Figure 128 in the Wheel and Axle Manual is not applicable to the one-wear cast-steel wheel, but is applicable to multiple-wear cast-steel wheels; as recommended by the Committee on Wheels.

Rule 82

The committee recommends that first paragraph of this rule be modified to refer to remount limits a, b, c *and d,* and that a new paragraph (d) be added to read as follows:

(d) Rim broken: Cast-iron or cast-steel wheels removed from service account condition of axle or mate wheel, shall be classed as scrap if width of tread, measured from flange at a point ⅝ in. above tread, is more than 3½ in. but not more than 3¾ in. and the fracture inclines outwardly.

Reason—Wheels having such defect should not be remounted, as recommended by the Committee on Wheels.

Rule 86

The committee recommends that second and third paragraphs of Section (b) and last paragraph of Section (d) of this rule be eliminated.

Reason—Account obsolete. Rule 3 requires A. A. R. Standard axles on all cars in interchange.

Rule 87

The committee recommends that third sentence in Paragraph (a) of this rule be modified, effective August 1, 1938, as follows:

Proposed Form—However, if wrong repairs of brake hangers, bolts in place of rivets, or wrong size bolts or pins, are not corrected within nine months from date of first receipt of car on home line, *or not corrected on any line* within one year from date of such wrong repairs, *counterbill* for correcting same is prohibited.

Reason—To harmonize with changes in Rules 5 and 94.

Rule 88

The committee recommends that first paragraph of this rule be modified as follows:

Proposed Form—Rule 88. In order that repairs of owner's defects may be expedited as fully as possible, foreign or private

line cars may be repaired by the handling line by using material from their own stock instead of ordering from owner special material not specified in last paragraph of Rule 122, in which event the repairing line must issue its defect card for the labor only of correcting such improper repairs, and defect card should be so marked; except *as otherwise provided in Rule 17, and in cases where* the following substitutions are made defect card must be issued for material and labor of correcting, regardless of responsibility for the repairs:

Reason—Account change in Rule 17, Paragraph (i-5).

RULE 94

The committee recommends that second sentence of first paragraph of this rule be modified, effective August 1, 1938, as follows:

Proposed Form—However, if wrong repairs of brake hangers, bolts in place of rivets, or wrong size bolts or pins, are not corrected within nine months from date of first receipt of car on home line, *or not corrected on any line* within one year from date of such wrong repairs, *counterbill* for correcting same is prohibited.

Reason—To harmonize with changes in Rules 5 and 87.

RULE 98

The committee recommends that first paragraph of Section (c) of this rule be eliminated.

Reason—Obsolete. Rule 3 requires A.A.R. Standard axles on all cars in interchange.

The committee recommends that reference in fifth paragraph of Section (c) of this rule to Rule 70 (c), be modified to refer to "Rules 70 (c), *73 (a) and 83,*" to harmonize with the latter rules.

RULE 101

The committee recommends that note preceding Item 69 of this rule be modified, effective August 1, 1938, as follows:

Proposed Form—Note—The following prices for extra-heavy pipe fittings may be charged, regardless of kind of fittings removed, *except for hand rails on tank cars where charge must be confined to single-weight fittings if standard to car.*

Reason—Account change in Section (k) of Rule 17.

The committee recommends that Items 201, 202 and 203, which specify prices for non-A.A.R. axles, be eliminated, account absolete. Rule 3 requires A.A.R. Standard axles on all cars in interchange.

The committee recommends that a new third note be added following Item 213 of this rule, effective August 1, 1938, to read as follows:

Note 3—Brake beams having more than one class number cast on strut shall be classified under the lowest class marking for charge and credit purposes.

Reason—Conflicting class number markings on brake beams are not contemplated under the A.A.R. specifications.

The committee recommends that second sentence of Friction Draft Gear Note, preceding Item 250 of this rule, be eliminated.

Reason—Account changes in Rules 17 and 88.

RULE 104

The committee recommends that Sections (a), (b), (e), (f) and (l) of this rule be modified, effective August 1, 1938, as follows:

Proposed Form—(a) (1) Secondhand A.A.R. type E couplers of rigid, swivel or radial design, shall be charged and credited at 75 per cent of value new. Credit shall be allowed for all parts of such couplers.

(2) Secondhand A.A.R. type D couplers of rigid, swivel or radial design, shall be charged and credited at *60 per cent of* value new (except that the swivel yoke, butt casting and pin or radial butt casting, shall be charged and credited at 75 per cent of value new). Credit shall be allowed for all parts of such couplers.

(3) Secondhand former standard or temporary standard couplers or parts of same shall be charged and credited at *30 per cent* of value new. Etc.

(b) Secondhand swivel yokes, butt castings and pins or radial butt castings; also, secondhand cast-steel yokes of other types having 24⅝-in. pocket spacing and secondhand two-key forged yokes having 24⅝-in. pocket spacing, designed for 1½-in. by 6-in. horizontal cross keys; shall be charged and credited at 75 per cent of value new.

(e) (Eliminate.)

(f) In the case of missing material under Rule 95, and permissible substitutions are made per Rule 17, car owner may be charged or credited with any difference between value of new or secondhand material applied and the secondhand value of missing material. Etc.

(l) (7) Coupler yokes, except as provided in Section (*b*).

Reason—To adjust secondhand allowance for older types of coupler commensurate with the expense of reclamation, as recommended by the Committee on Couplers and Draft Gears.

RULE 107

The committee recommends that the wording of Item 243 of this rule be modified as follows:

Proposed Form—243. Stenciling car or altering stenciling, to show A.A.R. type D or E coupler applied *or approved draft gear applied,* per car, net.

Reason—Account change in Rule 17.

RULE 108

The committee recommends that the following item be added to Section (a) of this rule, effective August 1, 1938: *Turnbuckles, tightened (other than body truss rods).*

Reason—It is felt no charge should be permitted for this operation.

RULE 112

The committee recommends that seventh paragraph of Section B of this rule be modified as follows:

Proposed Form—(B-7) A steel superstructure frame *house or open-top* car (*Class B*) is a *steel underframe* car having *side-sill members, top side members, uprights and diagonal upright braces, all steel and all* riveted *or welded* together.

Reason—To more clearly define this type of car and indicate its application to certain classes of open-top cars as well as house cars.

Passenger Car Rules

RULE 4

The committee recommends that the effective date of second paragraph of this rule, with reference to equipping all-steel or steel-underframe cars with cardboards or suitable receptacle for the accommodation of defect and joint evidence cards, now set at January 1, 1939, be extended to January 1, 1940.

Reason—The present situation justifies this extension.

RULE 7

The committee recommends that Paragraph (4) of Section (f) of this rule be modified to read as follows, changes from the present rules being in italics:

(f-4) Tread worn hollow—cast-iron and *one-wear* cast-steel wheels: If the tread is worn so that projection on under side of gage does not come in contact with tread of wheel. (See Fig. 4-D of freight code).

Tread worn hollow—wrought-steel *and multiple-wear cast-steel* wheels: If height of flange is 1½ in. or over, as measured with standard steel-wheel gage (see Fig. 128 in Wheel and Axle Manual), or approved equivalent.

Reason—Gage shown in Fig. 128 in the Wheel and Axle Manual is not applicable to the one-wear cast-steel wheel, but is applicable to multiple-wear cast-steel wheels; as recommended by the Committee on Wheels.

The committee recommends that Paragraph (1-a) of Section (h) of this rule be modified, effective August 1, 1938, as follows:

Proposed Form—(a) Such crack extends beyond *the shaded* area shown in Figure *D* of Freight Rule 18 (3 in. above and 3 in. below the horizontal center line of knuckle side wall and *7½ in.* back of front edge of knuckle side wall). *When crack extends beyond the shaded area, the coupler body is condemned and must not be reclaimed by welding.*

Reason—To harmonize with change in Freight Rule 18, as recommended by the Committee on Couplers and Draft Gears.

RULE 8

The committee recommends that a new Item 17 be added to Section (a) of this rule (Delivering line defects), to read as follows:

(17) *Raked sheathing to be cardable if raked to extent shown in Freight Rule 4 for refrigerator cars.*

Reason—It is felt the same limits as provided in Freight Rule 4 should apply for carding raked sheathing on passenger equipment cars.

RULE 15

The committee recommends that a new third paragraph be added to this rule, to read as follows:

In replacing generator belts or brake shoes on foreign cars, new material must be used to justify bill.

Reason—It is felt new material should be applied in such cases to warrant charges versus car owner.

RULE 18

The committee recommends that this rule be modified, effective August 1, 1938, as follows:

Proposed Form—Rule 18. Settlement for passenger equipment cars destroyed shall be based on cost of reproduction in kind at date of destruction. Depreciation shall be *computed* at 3 per cent per annum (straight depreciation basis) from date originally built, *except that depreciation on that portion of the cost charged to capital account for air conditioning system on cars so equipped shall be computed at 5 per cent per annum from date of installation.* Depreciation shall not exceed 80 per cent of reproduction cost.

Note.—In cases where air-conditioning system was installed coincident with construction of car, the amount charged to capital account for such installation may be estimated.

Reason—To provide an equitable settlement basis for the detail specified.

The report was signed by W. H. Flynn (chairman), general superintendent motive power and rolling stock, New York Central; J. P. Morris (vice-chairman), Atchison, Topeka & Santa Fe; J. A. Deppe, superintendent car department, Chicago, Milwaukee, St. Paul & Pacific; L. Richardson, mechanical assistant to vice-president and general manager, Boston & Maine; M. F. Covert, general superintendent equipment, General American Transportation Corp.; G. E. McCoy, assistant general superintendent car equipment, Canadian National; A. E. Smith, vice-president, Union Tank Car Company; R. G. Bennett, general superintendent motive power, Pennsylvania.

The report was adopted.

S. P. Streamline 4-8-4 Locomotives

(*Continued from page 246*)

walls and reduced hub diameter. They are fitted with the Locomotive Finished Material Company's bronze packing rings.

The valve-chamber bushings and bull rings are of Hunt-Spiller gun iron and the valves are fitted with Hunt-Spiller duplex sectional valve packing rings.

Both lots of locomotives are equipped with the Alco power reverse gear. On the later locomotives, however, the increase in the diameter of the driving wheels required that the reverse shaft be located back of the link, whereas in the earlier locomotives it was located directly over the front drivers in front of the link.

In other respects the running gear and motion work are essentially the same on both lots of locomotives. The rods and valve motion have Alemite-fitted grease cups and the guides are lubricated from the force-feed cylinder lubricators.

The streamlining of these locomotives is simple and effective. It consists essentially in a skyline casing over the top of the boiler within which are concealed the steam dome, sand box, safety valve and turrets. The front end has been changed relatively little from conventional design beyond the fairing the headlight casing into the center of the smokebox door. The pilot is covered, and from the sides of the pilot, sweeping in a broad curve over the sides of the steam chest, is a deep skirt which extends along the side of the locomotive below the running board to the cab. The remainder of the effect has largely been obtained by the use of red and yellow colors with striping in aluminum. The air compressors are mounted on the side of the boiler and the bell is placed below the smokebox, from which it is supported.

Partial List of Equipment and Materials on the Second Lot of Southern Pacific 4-8-4 Type Locomotives

Bed casting; engine and trailer trucks; Boxpok driving wheels	General Steel Castings Corp., Eddystone, Pa.
Tires	Standard Steel Works Co., Burnham, Pa.
Lateral cushioning device	American Locomotive Co., New York
Driving-box cellar	Franklin Railway Supply Co., Inc., New York
Coupler pocket	National Malleable and Steel Castings Co., Cleveland, Ohio
Radial buffer	Franklin Railway Supply Co., Inc., New York
Throttle, multiple	American Locomotive Co., New York
Superheater; steam dryer	Superheater Company, New York
Injectors and injector checks; safety valves	Nathan Manufacturing Co., New York
Feedwater heater	Worthington Pump & Machinery Corp., Harrison, N. J.
Speed recorder	Valve Pilot Corporation, New York
Steam gage	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Air brakes	Westinghouse Air Brake Company, Wilmerding, Pa.
Steam heat	Vapor Car Heating Co., Inc., Chicago
Water gage	Nathan Manufacturing Co., New York
Whistle, steam	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Whistle, pneumatic	The Leslie Co., Lyndhurst, N. J.
Bell ringer	Transportation Devices Corp., Indianapolis, Ind.
Sander	Viloco Railway Equipment Co., Chicago
Dynamo and headlights	Pyle-National Co., Chicago
Staybolt iron	Ulster Iron Works, Dover, N. J.
Staybolts	Flannery Bolt Co., Bridgeville, Pa.
Smokebox hinge	The Okadee Company, Chicago
Valve-chamber bushings and bull rings	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Piston-rod and valve-stem packing	Paxton-Mitchell Co., Omaha, Neb.
Reverse gear	American Locomotive Co., New York
Lubrication	Nathan Manufacturing Co., New York
Flange lubricator	Lima Locomotive Works, Lima, Ohio Alemite Div. Stewart-Warner Corp., Chicago
Flexible joints, McLaughlin	Franklin Railway Supply Co., New York
Tank valve	Crane Co., Chicago
Tender:	
Frame	General Steel Castings Corp., Eddystone, Pa.
Trucks, truck side frames and boxes	Buckeye Steel Castings Co., Columbus, Ohio
Clasp brake	American Steel Foundries, Chicago
Wheels	Edgewater Steel Co., Pittsburgh, Pa.
Draft gear	W. H. Miner, Inc., Chicago

The Tenders

The tenders of the two orders of locomotives are of the same capacity, carrying 6,010 gallons of fuel oil and 22,000 gallons of water. They are rectangular in form and are built up on General Steel Castings water-bottom underframes. The trucks are the Buckeye six-wheel type with 7-in. by 14-in. journals.

The locomotives are fitted with the No. 8ET brake equipment and the HSC train brake, and have both steam and pneumatic whistles.

EDITORIALS

Progress in Freight Car Construction

When some basic development in science or an improvement in an art removes certain limitations from which the designer has never before been free there is a natural tendency for him to give free reign to his imagination in counting up all of the useful possibilities which may come from the application of a new material or a new process or a new method. His visualization of the possibilities is almost sure to include some extremes of application, the true economic value of which can only be determined by the most careful study. Indeed actual trial and experience is usually essential before the boundaries of the true field for the application of the new developments can be clearly established.

The possibilities for the application of new materials and new methods in car construction is a case in point. At the outset of the availability of the new materials of construction which have become available during the past few years, they were applied in the construction of passenger equipment. The economic objective was weight reduction. Nothing which could increase the extent of weight reduction in connection with the applications of the new materials was overlooked, so that the end result might be the maximum obtainable. The ultimate costs of some of the extreme measures for accomplishing this desirable end, in convenience, in reliability, as well as in dollars and cents, have proved too great in practice, however, and the tendency is now toward a recession in certain aspects of weight reduction.

Somewhat the same situation has been developing with respect to freight cars. Here both new materials and an extension of the welding processes into this field has led to the same urge to accomplish the maximum in weight reduction without regard to the relation of weight to other objectives of a balanced design. Some excellent work has been done in demonstrating the remarkable possibilities both of the new material and of the extended application of welding. To accept these results, however, without a careful study of all of the possible combinations of the old and the new would quite possibly result in failure in the ultimate attainment of that degree of weight saving from which the optimum economic result can be attained.

Real progress is therefore being served by the proposed program announced by the Car Construction Committee in its 1938 report. This involves a cooperative effort of the car builders, the railroads and the manufacturers of special equipment for a thorough study of the comparative possibilities of carbon steel of riveted construction, of alloy steel with a combination of welding and riveting, of alloy steel with the riveting reduced to a minimum, and of carbon steel with a combination of riveted and welded construction. Such a series of studies is bound to be stimulating in the practical advancement in the use of the new materials and in finding the most practicable combination of riveting and welding in car construction.

The Welding of Low-Alloy Steels

The modern high-strength low-alloy steels have been developed to meet specifications calling for 75,000 to 95,000 lb. per sq. in. minimum ultimate strength, together with ease of fabrication and good weldability. The combinations of the alloys in the steels offered by the various steel companies differ widely, but each of them meets these requirements. It is of importance to note that these steels differ from their predecessors in that they may be welded without seriously affecting the metal next to the weld proper. This result is achieved by the use of chromium, manganese or nickel, or some combination of these elements with silicon, vanadium, molybdenum, phosphorus or copper with carbon at a low level. From a fabrication standpoint, it matters little which combination is used, providing the alloy combination is well balanced and the physical properties are attained with carbon at 0.14 per cent or less in the 75,000 lb. per sq. in. grade and 0.22 per cent or less in the 95,000 lb. per sq. in. grade. The alloy content of each of the low-alloy steels is sufficiently low so that no difficulty is found in welding them because the flowing properties and controllability of the weld puddle, when using any of the better standard welding rods or electrodes, are satisfactory for general-purpose welding.

The problem which must be given the most serious consideration involves the air hardening of the steel in the zone adjacent to the weld, which hardening may be definitely correlated with the carbon content and the ultimate strength of the steel. Light-gage steels in the 0.14 per cent carbon class may be classified as full-proof in so far as welding is concerned. However, those steels having higher-carbon contents and an ul-

timate strength not in excess of 95,000 lb. per sq. in., as well as lower-carbon steels of heavy gage, are also being welded satisfactorily when stress relieving is applied. A complete study of the problem of welding low-alloy steels shows that they can be welded as readily as plain carbon steels, providing intelligent welding practice is followed and use is made of modern welding equipment and improved types of welding rods or electrodes.

What Next?

An examination of the files of an early English publication discloses the following quotation: "Yesterday morning, when the six o'clock Birmingham train arrived at the station in Euston-square, a hare was discovered perfectly roasted and nearly consumed in the ash pit of the furnace of the steam engine. The animal, it is supposed, being alarmed, was driven for refuge into this dangerous position."

Bearing out the adage that the first story-teller has no chance in comparison with the last, this yarn about the hare in the English locomotive ash pan is entirely out-classed by the well-authenticated fact that, within recent months, a streamlined fast passenger train from the west arrived at the Chicago terminal with a *fish* in the *locomotive headlight.* Since fish do not fly, at least in the inland territory of the United States, the explanation of this phenomenon is thought to be somewhat as follows: While the train was passing through some mountainous country, an eagle must have collided with the locomotive headlight, broken the glass and deposited its catch, no doubt to the vast disappointment of a nest full of hungry eaglets in some mountain fastness.

In view of the two incidences cited, it may well be asked—what next in the way of live stock will be picked up by some meandering locomotive?

Diesel-Electric Locomotive Progress

In its 1938 report the Committee on Locomotive Construction of the Mechanical Division included statistics concerning the use of the Diesel-electric locomotive by the railways of the United States and Canada which represent facts of sufficient importance to warrant emphasis. The data in the report indicates that since the first Diesel-electric was placed in regular service in 1925 there have been 389 units installed in the 12 succeeding years, 354, or 91 per cent of which, are in service in the switching field and most of the remainder, 27 out of 35 to be exact, are in high-speed passenger road service.

Like the development in the rail-car field the Diesel-electric locomotive has followed a trend toward locomotive units of higher horsepower as well as engine units of increasing horsepower as time has gone by. Up to the end of 1929, when a total of only 40 units had been installed, 27 of these were equipped with 300-hp. engines and 10 units had a total of 600 engine horsepower, although some of these latter were undoubtedly made up of two 300-hp. engines. The year 1930 was the peak year for the installation of 300-hp. engines, after which the number of units utilizing this size of prime mover gradually decreased until, in 1937, the year in which the greatest number of units was installed, there was only one 300-hp. unit built. Coincident with the decline in the use of the lower-powered units came a steady increase in the use of larger units until in the year 1937 of the 155 units installed 87 were of 600 horsepower and 42 were of 900 horsepower and practically all of these 129 locomotives were single-engined units. Sixteen of the locomotives installed in 1937 were of a total horsepower in excess of 1,000, the maximum being 5,400. Prior to 1935 no locomotive of this type had been built with greater total horsepower than 1,330. During the years 1935 to 1937, inclusive, the trend to higher engine horsepower went up into the range including 1,200 and, in one case, 2,000 hp. in a single engine, but, for the most part the units installed embodied the use of 600- and 900-hp. engines, many of which are supercharged. The trend toward the use of multiple-engined locomotive units is indicated by the fact that all the locomotives of 1,800 hp. and over—a total of 19—embody the use of 55 Diesel engines, 43 of which are 900 hp. and the remainder are 1,200 hp., except one engine unit of 2,000 hp.

The report referred to indicates that 40 per cent of all the locomotive units in service were installed in the year 1937 but it is worth while to add to the data included in the report the fact that, from the standpoint of the number of engine units installed and the total engine horsepower, the year 1937 was outstanding. In that year, and two months of 1938, more Diesel engine horsepower was installed in railroad service than had been installed in the 12 previous years. A chart indicating these installations, year by year, appeared on page 223 of the June, 1938, *Railway Mechanical Engineer.*

The last five years has witnessed the introduction of 69 per cent of all the Diesel-powered locomotives now in service and the experience of the railroads has now extended over a sufficient period of time to justify the prediction that this form of power has not only found a very definite place in the transportation field but that its use will continue to expand. The economies in the field of switching service are recognized and as additional installations are made, particularly on the smaller roads, we shall undoubtedly soon reach the point where the maximum economies of Diesel-electric operation may be realized where the steam switcher has been com-

pletely displaced and the cost of maintaining servicing facilities not required for Diesel operation can be eliminated.

The committee is to be commended for the recommendation that the association adopt a uniform report for collecting statistics on the cost of maintenance and operation of Diesel-electric locomotives. Now that this type of power has become firmly established in the railroad field it is of the utmost importance that comprehensive and accurate cost figures be developed for the benefit of the industry at large. It is of equal importance that the data be uniform in character. In the light of past experience it is to be hoped that the roads now operating this type of motive power will cooperate with the committee in developing the statistics of operation in such a manner that all who are interested will recognize that many of the controversial points in such statistics have been taken into consideration with a view to breaking down the resultant data into sufficient detail that it may be related to the varying conditions of service. As the use of Diesel-powered equipment increases the necessity for accurate data on availability and operating costs will become more apparent.

New Books

JIGS AND FIXTURES. *By Fred H. Colvin and Lucian L. Haas. Published by the McGraw-Hill Book Company, Inc., New York. 354 pages, 6 in. by 9 in. Price $3.50.*

This third edition of "Jigs and Fixtures" has been completely revised. It contains an extract from the paper by Prof. J. V. Roe on the economies of jig and fixture design, and, included in the standard practice from such concerns as the Taft-Peirce Manufacturing Company, the Westinghouse Electric & Manufacturing Company, and others, are examples of modern die sets to show their close relation to jigs and fixtures. Standards of jig bushings and of T-slots, tongues and bolts are given as well as many new details of various features to assist the designer in producing efficient and economical work-holding devices.

TESTS OF STRENGTH PROPERTIES OF CHILLED CAR WHEELS. *A report of an investigation conducted at the Engineering Experiment Station, University of Illinois, in cooperation with the Association of Manufacturers of Chilled Car Wheels, by R. E. Richart, R. L. Brown and P. G. Jones. Published as Bulletin No. 294 of the Engineering Experiment Station, University of Illinois, Urbana, Ill. 67 pages, 6 in. by 9 in., paper bound.*

This bulletin reports the results of tests of standard A. A. R. single-plate car wheels which were conducted along lines used in tests made 15 years ago on double-plate wheels, the manufacture of which ceased in 1928; the results of the tests made 15 years ago were reported in Bulletins Nos. 129, 134 and 135 of the University of Illinois Engineering Experiment Station.

The wheels tested in the recent investigation, results of which are reported in Bulletin 294, represented the four standard sizes of A. A. R. single-plate wheels, with some deviations in design and dimensions. Most of the wheels were subjected to a series of tests as follows:

Series 1—The first studies included the determination of the strains developed at various points in the wheel as it was being mounted, or pressed on to a steel axle. At intervals, as the mounting progressed, observations were made of the mounting pressure and of radial and circumferential strains in the wheel hub and plate. A study of the effect of specially ground wheel seats, and of the repeated mounting and removal of wheels was made on part of the wheels. The results of these tests are discussed in Chapter IV.

Series 2—After two wheels had been mounted on an axle, vertical loads were applied to the journals with the wheels supported on 130-lb. standard rails, much as static loads would be applied in service. The increase in wheel strains over those produced in the mounting tests was noted. The loads were applied in increments, producing one, two, three, and four times the normal permissible wheel load. Strains and deflections in the axle were also measured. These tests are discussed in Chapter V.

Series 3—The tests of Series 2 were repeated, with a vertical load equal to the normal permissible wheel load, and with the addition of inward horizontal flange thrusts on each wheel at the point of rail contact. The thrusts employed were 25, 50, 75 and 100 per cent of a normal axle load (axle load equals two wheel loads). The increase in strains and axle deflections was noted. The description and results of the tests are given in Chapter VI.

Series 4—The last group of tests involved the resistance of the wheel rim to loads applied near the edge of the rim. These tests were undertaken in the expectation that their results might throw some light on the causes of the rather numerous rim failures which occur in service on badly-worn wheels. The tests were made on standard wheels, on wheels with profiles simulating a badly-worn tread, on wheels with thickened rims and with special plate designs, and on wheels which had received special heat treatment. These tests were carried to failure of the rims. They are described in Chapter VII.

In comparing freight car wheels of today with those of 15 years ago, considerable improvement in the single-plate design was found. Wheels of today are better in metal, in hardening of tread, and in design. Also, different weights of wheel were found to compare well in design. In studying the breakage of wheel rims on the side away from the flange, thickening the rim, and several other small changes indicated the possibility of further improvements in lengthening wheel life.

THE READER'S PAGE

Proud of Apprentice Training System

To the Editor:

In reading the May and June issues of the *Railway Mechanical Engineer* I was particularly interested in the difficulties experienced by apprentices on other railroads in getting proper training during their apprenticeships.

I am proud to say that our railroad really trains us during our term of apprenticeship, which I, for one, deeply appreciate.

We have a technical training assignment that we are required to qualify on every month of our own time and we have to pass a monthly test. All of our instruction is individual instruction. In this training we are taught fundamental subjects, such as reading blue prints, making freehand shop sketches, principles of layout work by means of geometrical and mechanical drawing, projections, developments, etc., shop arithmetic and shop measurements. After we finish these subjects we have shop practice and layout work in our trade.

We have a shop training schedule that is followed and our foreman rates us every month on our shop work, as compared with an average mechanic on the same work; also on our interest, initiative, craft skill, safety, conduct, etc.

We have an apprentice club, elect our own officers and conduct our own meetings. We meet once a month except in July and August. The principal speakers at these meetings are supervisory officers from the various departments—the operating, transportation, stores and mechanical. They tell us the function of their job and let us ask questions and discuss it. In this way I feel that we learn something about the operation of the other departments that go to make up our railroad, in addition to learning a trade.

Fred Robinson,
Machinist Apprentice, D. & R. G. W.

Machining Piston-Rod Key Slots

To the Editor:

I was much interested in an article in the January issue on machining the key slot in piston rods and crossheads in which "Foreman" describes a method of doing this job on the milling machine. I believe the majority of modern shops still do this job on the drill press and find that it can be done satisfactorily by this method. The method found most convenient is as follows: The slot in the crosshead is carefully laid out and the crosshead clamped to the tilting table of a radial drill press and a line of holes drilled to remove as much metal as possible from the slot. The table is tilted to an angle of 45 deg. to do this job as the slot is at an angle of 45 deg. with the wearing surface of the crosshead. When it is desired to taper the slot, this may be done by shimming up one end of the crosshead. A milling cutter or a rose bit is then placed in the spindle of the drill press and used to cut out the metal left between the row of drilled holes.

To drill the piston rod, the crosshead and piston rod are assembled at the bench and the rod is driven back as far as possible into the taper fit of the crosshead, after which the outline of the slot in the rod is scribed. The rod is then removed from the crosshead and the slot laid out with dividers to drill a suitable line of holes. The slot is set ahead about ½ in. to allow sufficient draw and clearance, and is laid out on both sides of the rod to facilitate setting up on the drill-press table with a combination square and scale. The rod is clamped on the table, the table tilted to give the proper taper to the slot, which is drilled clear through, and the metal between the holes milled out in the drill press at one set-up.

Machine Foreman.

Another Cause of Piston-Rod Failures

To the Editor:

I read with a good deal of interest the letter in the January issue covering the cause of failures of piston rods. I can't agree with this foreman that most failures are caused by the improper machine work done when making the keyways for the draw key.

First, to summarize the draw key and the keyway in the rod, I feel that it is important (1) to machine the keyway in the rod, at the back wall of the fit, squarely in the center of the rod, (2) to locate the keyway the proper distance from the back end of the rod to give the desired strength, (3) to machine the keyway at this point so that it has the proper taper, and (4) to machine the key and the keyway to the same taper. As for the front end of the keyway, it is necessarily ahead of the full width of the key for clearance and the amount of taper at this point does not seem so important. I agree that the keyway for the desired length should be of uniform width and so machined that the possibility of fractures starting from undesirable tool marks be held to a minimum. An important item in the finishing of the keyway is to remove the sharp edges of the keyway after machining by applying a full-length fillet at both the top and bottom of the keyway.

It has been my experience that although many piston-rod failures, have been caused by fatigued metal, the majority of such failures are caused by the lack of a full bearing between the rod and the crosshead. I have seen several methods of making this fit to the crosshead, but in my opinion the best method is to ream the crosshead fit and then set the lathe, in which the piston rod is to be turned, to the exact taper of the reamer. The piston-rod fit should be machined so that when just snugly applied to the crosshead, the rod will enter the crosshead within 1/16 to ⅛ in. of the desired point when pulled in with the key. The two parts should then be lapped together with moderate grinding compound to assure a bearing over the full length of the fit. Without this good bearing the fit is not uniform and an added strain is thrown on the rod, which in time will affect the weakest part of the rod, that is, the keyway.

I might add that I agree fully that only the most experienced mechanic should be allowed to handle work of this type.

Enginehouse Foreman.

Gleanings *from the* Editor's Mail

(The Apprentices Speak)

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Apprentices Hard Hit

During these days the apprentice does not get a fair deal, in most instances not because the company he works for has no interest in him, but because during intermittent shop operation more attention must be paid to the present and less to the future. An apprentice evening school was organized here with considerable interest and success. However, due to a lay-off of long duration the school had to be abandoned.

Stiffen Requirements for Apprentices

At the present pay scale for railroad apprentices we find at the end of four years a boy has probably earned more than the average young man earns in the four years following his graduation from high school. The point I am trying to stress is this. The railroad companies could afford to be more careful in their requirements for new apprentices. A boy should be required to have a fair knowledge of algebra and geometry, as well as machine drawing experience. For each six months of progress on his apprenticeship, a boy should be required to pass a mechanical examination on various types of machine work, characteristics of various kinds of metal in regard to machinability, etc., as well as locomotive technicalities. In the event a boy fails to pass these exams he, as well as the company, would benefit by his discharge from service, because no man can master a profession to which he is unsuited. Under this system a man, after completing his apprenticeship, may truthfully say, "I am a machinist."

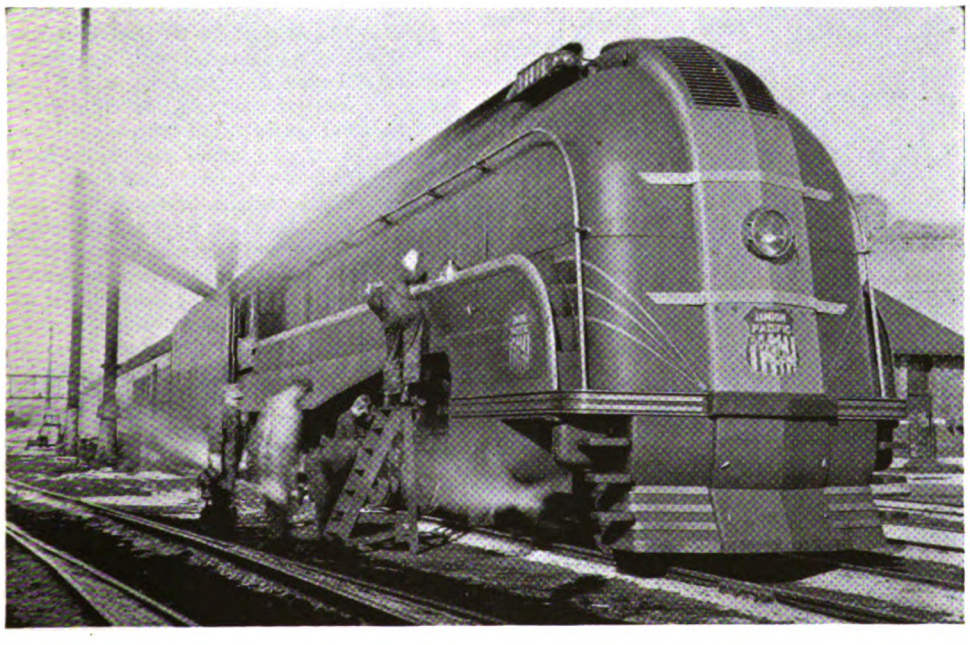
Observations of Special Apprentice

I feel as though I am very fortunate in that I am being trained in a line of work that enables me to do nearly everything of a mechanical nature, although working for this particular road seems to have its bad points also. There is lacking a feeling of security, which is caused by frequent shut-downs, and not knowing when or how long we will work; also due to seniority rules, whereby a great number of men are laid off due to lack of money to repair motive power. There is no place for the regular apprentice when he has served his time, which at present extends well into six years. There must be some solution.

Special Apprentice Makes Suggestions

We "specials" are sent around to different shops on the system to get a speaking acquaintance with as much of the mechanical department as possible inside of three years, working on a definite schedule of so much time here and so much there. This is all supposed to lead us into supervisory positions, starting as gang foreman on completion of the time—provided there are openings for us. We are sent into a shop to spend one or two days with a machinist on one job, and then a day or so on another job—nothing like enough time to really learn the job, but just enough to know that there is such a thing. We are rarely given any opportunity to get acquainted with the problems of the supervisors, which is really the thing we are expected to learn, or at least expected to practice later. I see no reason why we shouldn't spend a great part of our time, at least, with some definite responsibility as acting assistant gang foremen. It would be a much greater incentive to learn the business than just standing around half the time, not knowing enough to help a man, and feeling generally useless. They tell us our time of usefulness will come later, but surely it would do no harm to hurry it up a bit.

Photo by Thomas T. Taber



Servicing Union Pacific "Forty-Niner" at Green River, Wyoming

High Spots in Railway Affairs . . .

Business Trends

Freight car loadings are considered to be one of the best measures of business conditions. The Railway Age insists that on this basis a change in the trend of general business from downward to upward began early in May and loadings up to the latest reports since that time support this view. "Freight loadings," says the Railway Age, "have acted since April much as they did in September, 1932, when they afforded first evidence that the bottom of the depression had been passed. Like the improvement then, the improvement occurring now cannot logically or honestly be attributed to an increase of government lending and spending. But suppose it continues and the Washington propagandists of lending and spending attribute it to their program and get away with it? This will encourage the already widespread and dangerous belief among the people and even among business men that huge government spending is good for business and the people."

Utopia!

"I have noted with pleasure," writes one of the readers of this page, "that the *Railway Mechanical Engineer* has recently devoted some space to the political and economic aspects of the railroad situation, but I wonder if your arguments can do much to reverse the present trend. Some of the more obstreperous groups of railroad employees have more faith in the infallibility of certain labor newspapers than most churchgoers have in the Holy Bible. Many of the readers of these newspapers have been so affected by the incessant harping on watered stock, etc., that no power on earth could produce an argument convincing enough to cause any modification of their convictions. They seem to think that if the present situation can be continued long enough, it will inevitably result in government ownership and operation, which is their idea of Utopia. What a rude awakening the brotherhoods are going to have some day!"

Government Ownership?—No!

Fortune, in its July issue, published its Quarterly Survey: XIII. One of the questions asked in the survey was, "Do you think government should take over the railroads?" "Yes," replied 25.7 per cent, a slightly lower percentage than in a similar questionnaire published in January, 1936, eighteen months ago. "No," said 52.8 per cent, as compared to 51.8 per cent in January, 1936. The percentage which "don't know" was the same in both questionnaires, 21.5 per cent. "Now, as before," says Fortune, "sentiment against government ownership runs through every economic level, with decisive majorities of those having opinions, and by geography there is only one part of the country that favors it—the Pacific Coast, which also was found to be the most in favor of greater power for federal government, as against state government."

Congress and the Railroads

Congress having failed to enact any constructive legislation for the relief of the railroads, the Administration apparently is now resting its hopes on a general business revival that it anticipates will result from its pump priming activities during the summer and fall months. If the railroads fail to find some measure of relief in this way, there is some talk of the possibility of calling a special session of Congress in the fall. Naturally, in the face of a hotly contested election, such a move would not be welcomed by most of the legislators. It might insure quick action, however, since the members would be keen to get back home as quickly as possible. Hurried decisions under such circumstances might make the situation worse, rather than better. The House Committee on Interstate and Foreign Commerce has appointed a subcommittee to study the desirability of legislation to reorganize transportation and co-ordinate regulation as between competitive agencies. The Senate Committee on Interstate Commerce has not appointed such a committee, but Chairman Wheeler's subcommittee, of which much was expected during the early part of this year, may be inspired to turn its attention to a legislative program which will really be helpful in improving the railway situation. On the basis of its past accomplishments, however, this may be expecting entirely too much.

We Wonder!

We are all sympathetic with the desire to raise still higher the living standards in this country, even though they are now far beyond those of any other country in the world. But you can't divide what you haven't got, and in the effort to spread the national income more evenly, something somewhere has gone seriously wrong, and there is now far less income to divide than there should be. We have ample national resources and the plant and personnel to make and distribute the products that are in demand to meet the necessities, comfort and convenience of our people, but these facilities are either lying idle or are being utilized to only a small part of their capacity. According to the Department of Commerce, the estimated national income of the United States in 1937 was very nearly 70 billion dollars; in 1929 it was 80¾ billion dollars. In view of what has transpired following previous depressions, it should have increased to at least 90 billion dollars in 1938. Even the most optimistic predictions, however, do not place it above 60 billions—a shortage of 30 billions, or enough to pay off a substantial part of the national debt. Samuel O. Dunn, editor of the Railway Age, in an address at Owosso, Mich., on May 25, pointed out that "you cannot have a large national income unless you have constantly going on a large investment of capital. It is capital that employs labor, and if you keep capital from working, it will not employ labor." Economists seem pretty well agreed that the many attacks which have been made on capital are largely responsible for the present state of affairs. Looks like cutting off the nose to spite the face!

Spirit of the Dark Ages

Railroad labor leaders, flushed with victory in bluffing Congress to a standstill, take credit for blocking the passage of the bill to liberalize the requirements of the Reconstruction Finance Corporation in lending money to the railroads, so that under the present abnormal economic conditions they might avoid receiverships. These leaders not only deliberately refused to go along with the railroads, unless the latter withdrew from their effort to reduce railway wages, but brought pressure upon Congress and the Administration to prevent the law being enacted; this in spite of the fact that under the Railroad Labor Act, wage reductions can only be made under slow and orderly processes, in which the workers are amply protected at every turn. As a result, with rates maintained at too low a level by the Interstate Commerce Commission and with no constructive or remedial legislation enacted at the last session of Congress, and little pick-up in general business, the railroads must continue to struggle along and neglect activities which would have called men back from their furloughs, or would have added to the small working time and earnings of others. Meanwhile, the men at the top of the seniority lists in the operating services march on undismayed by the plight of their less fortunate fellows, refusing to give up even a little of their advantage; yes, more than this, they unblushingly exerted all the power they had to embarrass the railroads and force them to greater extremities, even though it meant pushing their less fortunate fellows back down into the pit of unemployment. This statement is made in spite of the fact that the railroad labor leader spokesman insists that opposition to the bill was withdrawn near the close of the session. It was too late then to do good.

(Turn to next left-hand page)


This CHILLED CAR WHEEL
is one of more than
16,000,000
in use on North American Railroads
Chilled Wheels possess qualities not found in wheels made from other materials. Their surface hardness makes them long lived. The heaviest loads have no effect on rotundity because the metal will not flow. Increased Brake Shoe Life and minimum abrasion of rails lead to important maintenance economies. Reduced train resistance, due to lessened resistance between flange and rail, effects operating economies. Factor of Safety of Chilled Wheels is not exceeded by any other material. Quality and uniformity are maintained by a Centralized Inspection System which controls manufacturing operations from cupola to final inspection.
ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS
445 N. Sacramento Blvd., Chicago, Illinois
230 Park Avenue, New York, N. Y.

NEWS

Purchases and Stores Committees Meet

In lieu of its convention, the Purchases and Stores Division, A. A. R., will hold a meeting of its General and Advisory committees at the Palmer House, Chicago, on Wednesday, July 13, to consider the reports prepared by its committees, and to pass upon their release.

S. A. L. Locomotive Runs 20,049 Miles in a Month

Locomotive No. 249 of the Seaboard Air Line ran 20,049 miles during January, according to E. H. Roy, superintendent of motive power. During the month, the locomotive, one of the road's latest "Mountain" types, was at work pulling the Orange Blossom Special, limited train between New York and Florida, daily between Hermitage, Va., and Baldwin, Fla.

Stoker Order Postponed

The Interstate Commerce Commission has postponed from July 1 to October 1 the effective date of its order in the automatic stoker case. This action was taken after attorneys for 179 railroads filed suits in the federal district court at Cleveland, Ohio, on June 14, seeking to restrain an Interstate Commerce Commission order requiring installation of automatic stokers on all coal-burning locomotives. The order, issued last December, required that 20 per cent of the locomotives be equipped with stokers by July 1 and another 20 per cent each year thereafter.

B. & O. Places Diesels on N. Y.-Capital Runs

The Royal Blue and the Columbian, streamlined trains of the Baltimore & Ohio, making round-trips daily between New York and Washington, D. C., are now operated by 3,600 hp. Diesel-electric locomotives. The extension of Diesel power to regular service on these trains was effected with the recent delivery to the B & O. of two new locomotives from the La-Grange, Ill., plant of Electro-Motive Corporation. They are alike in every way to the four predecessors that were assigned some months ago to the Capitol Limited and the National Limited.

New German Diesel-Electric Embodies New Features

The German State Railways is experimenting with a new type of Diesel-electric train which rests upon springs fitted directly to the floor of the body frame and in which the Diesel engines and generators are installed in the protruding part of the front car, where, it is claimed, they are subject to a minimum of shocks. The train, which consists of three cars having a total length of 70 meters (229.6 ft.) has a dead weight of 113 metric tons, develops an average speed of 160 km.p.h. (99 m.p.h.) and can accommodate 100 passengers, according to consular reports. It differs from the conventional type of Diesel-electric train in that its two 600-hp. Diesel engines and their respective generators are carried in the forward part of the leading car and do not rest directly on the main trucks, as is customary in European practice. Furthermore the train rests on its main springs at the floor of the body frame instead of through the trucks. These springs are of a specially-designed transverse type and aid resistance against lateral movements in passage around curves.

B. & O. "Covered Wagon" Top Box Cars

The Baltimore & Ohio has recently assigned 100 new type covered wagon-top box cars to its two fast merchandise trains No. 117 and 118, running overnight between New York and Pittsburgh, Pa. The new cars replace conventional type express cars formerly used in this service, releasing them for use elsewhere on the road. The chief reason for installation of the new cars, officers state, is the advantage of greater shipping space which this type of box car affords, since the loading area of each exceeds that of the conventional type by 919 cu. ft.

Equipment Depreciation Rates

Equipment depreciation rates for 14 railroads, including the Missouri Pacific, the Chicago & Eastern Illinois and the Wheeling & Lake Erie, are prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies. The composite percentages, which are not prescribed rates, range from 3.35 per cent for the Tonopah & Goldfield to 15.82 per cent for the Okolona, Houston & Calhoun City.

The Missouri Pacific's composite percentage of 3.71 per cent is derived from the following prescribed rates: Steam locomotives, 3.47 per cent; other locomotives, 3.93 per cent; freight-train cars, 3.97 per cent; passenger-train cars, 3 per cent; floating equipment (leased), 2.91 per cent; work equipment, 3.65 per cent; work equipment (leased), 4.7 per cent; miscellaneous equipment, 10.98 per cent. The composite percentage for the C. & E. I. is 3.6 per cent, derived from prescribed rates as follows: Steam locomotives, 3.5 per cent; other locomotives, 4.85 per cent; freight-train cars, 3.54 per cent; passenger-train cars, 3.66 per cent; floating equipment, 4.78 per cent; work equipment, 5.27 per cent; miscellaneous equipment, 25 per cent. The W. & L. E. composite percentage is 3.71 per cent with prescribed rates as follows: Steam locomotives, 3.69 per cent; freight-train cars, 3.72 per cent; passenger-train cars, 4.39 per cent; work equipment, 3.47 per cent; miscellaneous equipment, 15.65 per cent.

N. Y. R. R. Club Outing

Some 850 railroad and supply men attended the annual outing of the New York Railroad Club on June 9 at the Westchester Country Club, Rye, N. Y. Golf and other games and diversions consumed the major part of the day while a banquet constituted the evening program. There were 382 entries in the various golf tournaments and 479 rounds of golf were played. The H. H. Vreeland trophy, for the first time since the inauguration of golf tournaments by the club in 1920, was captured by a team of railroad men who this time wrested it from railroad supply representatives. The winning team, which played a score of 322, included Harry Nunn, West Springfield, Mass.; R. Wainright, New York; F. W. Felde, Jackson, Mich.; W. J. Sasso, Cleveland, Ohio, all

(*Continued on next left-hand page*)

New Equipment Orders and Inquiries Announced Since the Closing of the June Issue

Locomotive Orders

Company	No. of Locos.	Type of Loco.	Builder
Seaboard Air Line	9	1,800-hp. Diesel-elec.	Electro-Motive Corp.

Locomotive Inquiries

Malahat Logging Co.	1	Oil-burning loco.	.....

Freight-Car Orders

Road	No. of Cars	Type of Car	Builder
Bethlehem Mines Corp.	7	Air-dump	Austin-Western Road Machinery Co.
Lehigh & New England	50	70-ton hopper-bottom[1]	American Car and Foundry Co.
U. S. Navy Dept., Bureau of Supplies and Accounts	3	Flat	Haffner-Thrall Car Co.
	1	Box	American Car and Foundry Co.
	2	Tank	American Car and Foundry Co.
U. S. Sugar Corp.	20	30-ton cane	Magor Car Corp.

Passenger-Car Orders

Road	No. of Cars	Type of Car	Builder
Canadian National	5	Mail and express	Canadian Car and Foundry Co.

[1] These are to be special-body, hatchway-roof, hopper-bottom steel cars for bulk-cement loading. Inquiry for this equipment was reported in the February issue of the *Railway Mechanical Engineer*.

THE

Daylight

CELEBRATES ITS FIRST BIRTHDAY...



...and claims a record!

On March 21st, 1938 the "Daylight", of the Southern Pacific Railway Company, celebrated its first birthday. On the same day it claimed the record of "The world's most heavily patronized one-section, long-distance daily train."

During this first year of operation, the north and south bound trains between Los Angeles and San Francisco carried a total of 253,573 passengers, an average of 695 passengers each day.

This record clearly shows the increasing public demand for comfortable, high-speed streamlined trains; trains that, like the "Daylight", are powered by steam locomotives capable of covering their route quickly, comfortably and economically.

LIMA LOCOMOTIVE WORKS LIMA LOCOMOTIVE WORKS INCORPORATED **INCORPORATED, LIMA, OHIO**

of whom are connected with the New York Central system. The winner of the Daniel M. Brady cup was E. D. Searle of the American Arch Company, who played a gross score of 78 and net of 72.

C. A. Gill, general manager of the Reading and president of the club, presided at the banquet.

R. R. Retirement Board Issues Regulations

THE Railroad Retirement Board has prescribed "Regulations Under the Railroad Retirement Act of 1937," effective as of June 1, 1938, which supersede all previous regulations. The following matters are governed by the regulations: Definitions, employers, employees, employment relation, employee representative, eligibility for an annuity, execution and filing of an application, annuity beginning date, relinquishment of rights, definition and creditability of service, definition and creditability of compensation, computation of an annuity, elections of joint and survivor annuities, payments at death, payments of benefits of $500 or less, pensions, reports, information, hearings and witnesses, recovery of erroneous payments, appeals within the Board, and applicability of 1935 or 1937 Act.

Machinists' Union 50 Years Old

THE International Association of Machinists, often called "The War Dogs of the Labor Movement," reaches its 50th year of existence this year, according to a short history of the union by A. O. Wharton, president of the union, which appears in the current Labor Information Bulletin of the United States Department of Labor. The first meeting of the machinists was held on May 5, 1888, by a group of ten men in the Atlanta (Ga.) shops of the Wilmington, Columbia & Augusta under the name of the United Machinists & Mechanical Engineers of America. This group later became Lodge No. 1 of the International Association of Machinists.

The article traces briefly the development and growth of the union, its "liberalization" to meet the changed conditions brought about by the use of semi-automatic and automatic machinery, its provisions for apprentices and its strike record. Mr. Wharton also devotes a paragraph to the negotiation in 1892 of the first agreement ever participated in between a railroad and its shop craft employees, which was signed by the machinists, boiler-makers, and blacksmiths with the Union Pacific and the Atchison, Topeka & Santa Fe. In 1919 the machinists also joined the Railway Employees department of the American Federation of Labor in agreements with the United States Railroad Administration. Present membership of the union is estimated to be in excess of 200,000.

Arch Bar Truck Date Extended

IN a circular sent to all car owners under date of June 25, 1938, J. M. Symes, vice-president, Association of American Railroads, Operations and Maintenance department, announces that the effective date of the interchange rule prohibiting the interchange of cars equipped with arch bar trucks has been extended six months. Interchange Rule 3, Sec. (t), Par. (4), in the 1938 code, provides that effective July 1, 1938, cars with arch bar trucks will not be accepted from car owners. The Board of Directors, in considering this rule, has extended the effective date until January 1, 1939.

According to a recent statement by J. J. Pelley, president of the A. A. R., only about two per cent of the total railroad-owned cars, which are regarded as suitable for service or worthy of repairs, are now equipped with arch-bar trucks.

Diesel Train Anniversaries

ANNIVERSARIES of Diesel train performance were celebrated by the Chicago & North Western-Union Pacific and the Chicago, Burlington & Quincy on June 20 and 21. The North Western observed the second anniversary of the Streamliner City of Denver, which operates between Chicago & Denver. The train, on entering the Chicago terminal, had completed 1,530,000 miles and up to the end of April had carried 190,000 passengers.

At 6:07 p. m. on June 21 the eight Zephyrs of the Chicago, Burlington & Quincy completed the five millionth Zephyr mile, which was recorded on a giant odometer, which had been constructed in the Union Station, at Chicago, and which gave the figures actually moving into place for the five millionth mile. At 6:07 p. m. one of the two Denver Zephyrs was near Aurora, Ill., the other near Ft. Morgan, Col. One twin Zephyr was near Savanna, Ill., and the other near East Winona, Wis. The Pioneer Zephyr was leaving Council Bluffs, Iowa, the Mark Twain Zephyr was approaching Hannibal, Mo., the Ozark State Zephyr was near Marshall, Mo., and the Sam Houston Zephyr was near Corsicana, Tex. The mileage each train contributed to the total of 5,000,000 miles is as follows: The two Chicago-Twin Cities trains, 2,007,743 miles; the two Chicago-Denver trains, 1,512,549 miles; the Lincoln-Omaha-Kansas City train, 547,701 miles; the Houston-Dallas-Fort Worth train, 353,040 miles; the St. Louis-Kansas City train, 308,673 miles; and the St. Louis-Burlington train, 270,294 miles. The Zephyr fleet has carried a total of 1,260,000 passengers.

La Follette Wants Carriers to Modernize—Under Pressure

CHARGES that railroad equipment is worn out and obsolete; that complete replacement of rolling stock ought to be made a national aim,—carried through by government pressure, if necessary, appear in a booklet published by the National Progressives of America, the so-called "third political party" recently organized by Governor "Phil" La Follette of Wisconsin. The booklet, which outlines the aims of the party makes reference to railroad modernization as an outstanding example of "spending for prosperity." It is pointed out that railroad equipment is worn out and obsolete; and that the carriers "haul from one end of the county to the other quantities of dead, unnecessary weight." It is then recommended that the carriers install "new, light metals, new engines, new road beds which would cut the cost of transportation and give the American people tremendously improved service."

"A government" says the bulletin "that saw the problem, and had the courage to act, could cut through the red tape in a few months. First, require an engineering survey (not a bankers', but an engineers') to determine what is needed to give our country the most efficient transportation system in the world. Next, order that it be done. Then, a judicial proceeding permitting the new capital financing it to step in ahead of the old bonds. Thus we would put three or four billion dollars of idle capital to work, create millions of new jobs, and when done we would have something real to show for our money. This would push the old bonds back, and let new money go to work. It would not destroy the old bonds—they would have just what they had before. But in place of idle men and idle money we would have working money and working men."

Five More Fusion-Welded Tank Cars

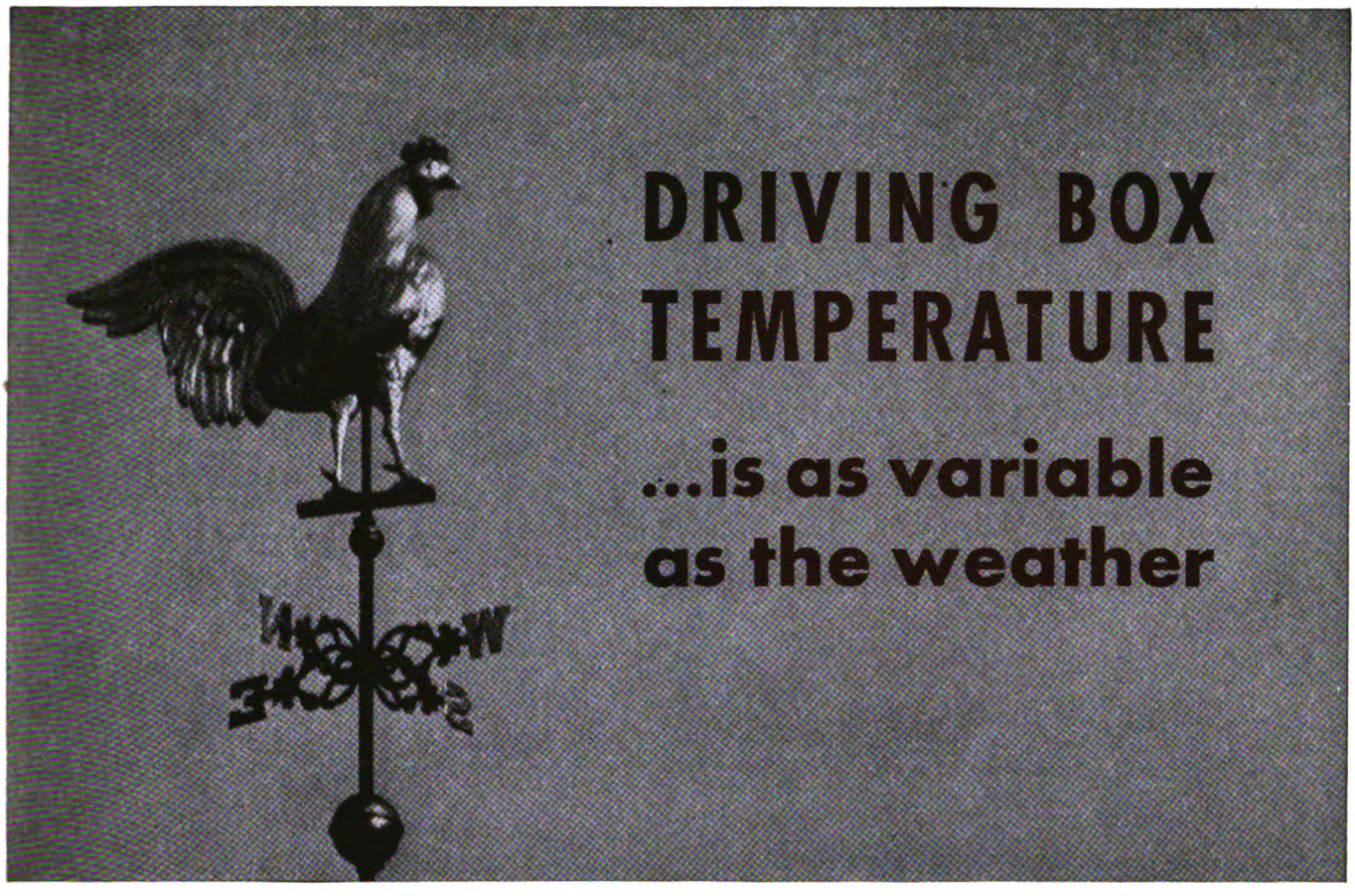
THE Interstate Commerce Commission, by Commissioner McManamy, has authorized the General American Transportation Corporation to construct five tank cars fabricated by fusion-welding for experimental service in the transportation of butyraldehyde. The report—a supplemental one in No. 3666, In the Matter of Regulations for the Transportation of Explosives and Other Dangerous Articles—states that the application, which was approved by the Tank Car Committee and Bureau of Explosives Association of American Railroads, was the first for authority to employ fusion-welded tank cars for butyraldehyde; although previous decisions have granted applications for authority to built a total of 522 such cars for experimental service in the transportation of "dangerous articles other than explosives."

Suggests Government Buy 300,000 Cars to Lease to Roads

SENATOR Shipstead of Minnesota, on June 23, submitted to Public Works Administrator Ickes a plan whereby the government would place orders immediately for at least 300,000 freight cars and sell them to the railroads on an installment payment plan. Mr. Shipstead estimated that the cost of the new cars would be $700,000,000 and he suggests that the government turn them over to the carriers under a lease-sale agreement extending over a period of some 15 to 20 years, carrying interest at the rate of 2½ per cent on the deferred balance. Mr. Shipstead described the proposal as a "project to sell for scrap the 300,000 obsolete freight cars that are now nothing but a source of additional out-of-pocket cost to the roads and replace them with new and modern equipment."

On June 24 the Senator talked with the President regarding his proposal and reported that Mr. Roosevelt was favorably

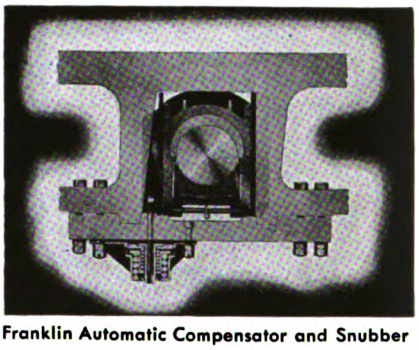
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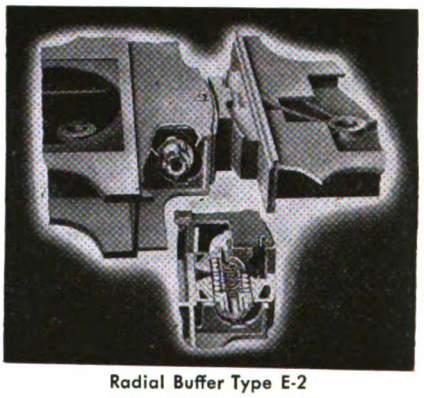
Due to friction, the temperature of the ordinary driving box varies as much as 250° in short periods of time. A wedge set when the engine is cool will be either too loose or too tight when the engine is running . . . But you *can* have your wedges correctly adjusted, even when running at top-speed.

The *Franklin Automatic Compensator and Snubber* adjusts the wedges automatically, compensating for expansion and contraction and maintaining accurate driving box fit at all times. It also compensates for wear and provides a spring-held snubbing resistance that cushions unusual shocks and maintains correct alignment of moving parts.

Its twin, the Type E-2 Radial Buffer, with its predetermined spring-held frictional resistance to slack and oscillation, maintains a constant engine-tender relationship. Together they make an easier riding locomotive and reduce track, car and locomotive maintenance.



Franklin Automatic Compensator and Snubber



Radial Buffer Type E-2

The close tolerances essential to efficient Booster operation call for genuine repair parts made by Franklin.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

impressed with it. At the same time the legal department of the Public Works Administration was studying the plan to see whether or not that agency could provide the financing for the 300,000 cars contemplated in the scheme, and the PWA was conferring with the Reconstruction Finance Corporation to see whether or not that agency would be interested in providing the money necessary for the construction.

The Senator said that he had received a large amount of corespondence regarding his plan and that none of the letters contained any unfavorable comment. President Pelley of the Association of American Railroads told reporters that he had received a copy of the plan and that the A. A. R. railroad presidents who were in Washington during the week ended June 25 attending a monthly directors' meeting, were favorably impressed with the idea.

The Senator's plan is based on the experience of the Minneapolis & St. Louis. According to Senator Shipstead, when L. C. Sprague, one of the trustees, took over that road in 1935, it was undermaintained. The road had 4,800 obsolete cars that had not moved for 15 years. One of the first things that Mr. Sprague did, according to the Senator's statement, was to scrap the old cars, and with some of the money received by this method, he bought 75 new freight cars outright. He also purchased 402 new freight cars on a "rental-lease" plan, similar to the one now proposed. These changes enabled the road to make substantial savings on the $1 a day charged it for the use of "foreign cars." In addition to this, continued Senator Shipstead, Mr. Sprague replaced the road's wooden passenger cars with steel underframe cars and scrapped 50 old light locomotives and equipped the heavier locomotives with the most modern devices.

Pennsylvania Authorizes $8,315,000 Equipment Purchases

THE Pennsylvania has authorized the construction of 1,000 gondola cars, 8 special type cars for freight service and 20 electric passenger locomotives, at a cost of about $8,315,000. An announcement of M. W. Clement, president of the railroad, says that this work is being undertaken to provide additional work for railroad employees at the Altoona, Pa., shops, to promote greater efficiency in transportation service to shippers and passengers and to improve the economical operation of the railroad. The gondola cars will be 52½ ft. long and of 70 tons' capacity, while the 8 special type freight cars will include 6 well cars of 120 tons' capacity and 2 flat cars of 200 tons' capacity. The 20 locomotives will be of the Pennsylvania's streamlined GG-1 type, especially designed for high-speed electric passenger service between New York, Philadelphia, Pa., Baltimore, Md., Washington, D. C., and Harrisburg, Pa. All of the freight cars and the chassis of the locomotives will be built in the railroad's Altoona shops and this work will provide more than 1,000,000 man-hours of employment in these shops as well as additional employment in the plants of the manufacturing companies where the electrical parts will be made.

Railroad Labor's Unemployment Bill

RAILWAY labor's unemployment insurance bill went through Congress during the last days of its session, and was later signed by the President, despite the Treasury Department's action in transmitting to House and Senate committees the advice it had received from the Bureau of the Budget that "the proposed legislation would not be in accord with the program of the President."

The bill contains 17 sections, and removes from the coverage of the unemployment insurance acts of the states and from Title IX of the Social Security Act the employees and employers covered by the Railroad Retirement Act of 1937 and the Carriers' Taxing Act of 1937. Thus in addition to railroad employees, eligible beneficiaries include their union representatives, although the latter are required to contribute three per cent of their monthly salaries up to $300—the same basis upon which railroad payrolls are taxed. Railroad employees will make no contribution. The Railroad Retirement Board will administer the unemployment insurance act.

Qualifications for and the amount of benefits are dependent upon the compensation earned by the employee during his "base year" which is the last completed calender year preceding a "benefit year." Benefits, computed on a daily basis, range from $1.75 to $3 per day in accordance with the amount earned during the base year. The maximum an individual can receive during a benefit year is 80 times his daily benefit rate, the range thus being from $140 to $240. The benefits provided are, for most employees and as a whole, more liberal than the benefits provided under existing state laws.

Special provisions are made for part-time workers and workers whose normal work shift extends over two days; in the case of the former group, only a day in which a part-time worker is normally employed may be counted as a day of unemployment, and in the case of the latter group, a 24-hour period is substituted for the calender day in counting days of unemployment. There are two conditions which an employee must meet to qualify for benefits—he must have earned $150 during his base year and he must have served a waiting period of unemployment before unemployment becomes compensable. Among the disqualifying conditions are those covering train and engine service employees who run up their monthly mileages in a comparatively few days. These are disqualified for benefits with respect to any half-month during which they perform 25 per cent of the maximum employment allowable to them for any calendar month, and with respect to any full month in which they perform at least 50 per cent of the maximum allowable. Strikers are disqualified if they are unemployed as a result of a strike "commenced in violation of the Railway Labor Act or in violation of the established rules and practices" of labor organizations, unless they "are not participating in or financing the strike and do not belong to a class of workers any of whom are participating in or financing or directly interested in the dispute." Payment of regular union dues "is not to be considered financing a strike within the meaning of this qualification."

Supply Trade Notes

WALTER K. Dow has been elected vice-president of the Alexander Milburn Co., Baltimore, Md.

◆

F. G. WOLF has been appointed manager of the Railroad Division of the Kenite Laboratory, Inc., 83 Murray street, New York.

◆

THE INTERNATIONAL NICKEL COMPANY, INC., New York, has established a new field office in the Grant building, Pittsburgh, Pa., under the direction of H. V. Beasley, who for the past three years has been attached to the New York office.

F. J. DEMAREST has been elected president, and H. G. Russell, treasurer and general manager, of Greene, Tweed & Co., New York.

◆

H. B. SPACKMAN, formerly in the steel products division of the U. S. Gypsum Company, has been elected vice-president in charge of sales and advertising of Lyons Metal Products, Inc., Aurora, Ill.

◆

M. FLANAGAN has been appointed southeastern representative of the Superior Hand Brake Company, Chicago, with headquarters at Richmond, Va.

N. B. ROBBINS has been appointed representative of the Hunt-Spiller Manufacturing Corporation, Boston, Mass., to fill the vacancy caused by the death of R. R. Wells.

◆

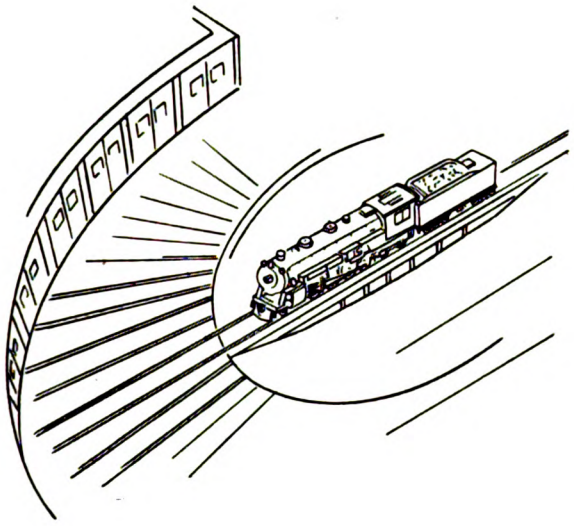
DAVID T. MARVEL has been appointed manager of tube sales for the Timken Roller Bearing Company, Canton, Ohio. Mr. Marvel's headquarters are at the main office in Canton.

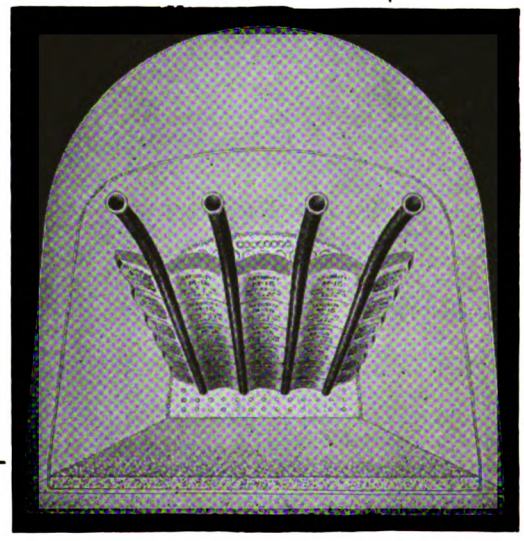
◆

W. R. SPILLER has become affiliated with the Timken-Detroit Axle Company, De-

(*Turn to next left-hand page*)

BE SURE
No Arch Brick
Is Missing





There's More to SECURITY ARCHES *Than Just Brick*

In these days of rigid economy, don't draw the line too fine and let a locomotive leave the roundhouse with an imperfect Arch due to lack of supplies.

A single missing Arch Brick has a mighty serious effect on steaming and on the efficiency of the locomotive.

Today, a dollar's worth of fuel means more than ever before. To spend it effectively, every Locomotive Arch should be maintained in perfect condition.

Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency will not suffer.

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

troit, Mich., as sales engineer. Previous to his new appointment, Mr. Spiller was chief engineer of the White Motor Company, Cleveland, Ohio.

◆

RAYMOND M. DENNIS, superintendent of flanging of the Lukens Steel Company, Coatesville, Pa., has been appointed general manager of the flanging department, in charge of estimating, sales and production on flanging work.

◆

THE DEVILBISS COMPANY, Toledo, Ohio, has transferred its manufacturing operations on rubber and synthetic rubber hose for spray painting, compressed air lines, gasoline pumps and other industrial uses, to its new hose plant at LaGrange and Gradolph streets, Toledo.

◆

THE SUPERGEAR DRIVE CORP., 105 West Adams street, Chicago, has been organized by W. A. McCallum and Ernest Lunn, and has acquired the exclusive manufacturing and sales rights to Type "B" Gear Drive and parts for the operation of train lighting and air-conditioning systems.

◆

GEORGE R. BOYCE of A. M. Castle & Co., Chicago, died at the Passavant hospital on June 14, after an illness of almost a year as a result of an automobile accident. Mr. Boyce became associated with A. M. Castle & Co., on January 1, 1912, and served as director and vice-president in charge of railroad sales for many years.

◆

EDWIN L. LARON has been appointed assistant sales manager of the Machine Tool Division of the Van Norman Machine Tool Company, Springfield, Mass. Mr. Larson was formerly chief engineer of the Baush Machine Tool Company and for the past two and one-half years has been in the engineering department of the Van Norman Company.

◆

GEORGE H. BUCHER, executive vice-president of the Westinghouse Electric & Manufacturing Company, has been elected president to succeed Frank A. Merrick, who becomes vice-chairman of the board, both with headquarters at Pittsburgh, Pa. Paul J. Myler, president of the Canadian Westinghouse Company, has been elected a director of the Westinghouse Electric & Manufacturing Company.

◆

THE EDWARD O'MALLEY VALVE CO., Blue Island, Ill., has purchased the Central Valve Mfg. Co., successor to the O'Malley-Beare Valve Company, and moved its offices to the Central's plant at 231 East Ninety-fifth street Chicago. Officers of the new company are: president, Edward O'Malley, Sr.; vice-president, Edward O'Malley, Jr.; secretary, J. G. McNeil; and general manager, S. C. Boston.

◆

W. J. MAYER has joined the staff of the A. M. Byers Company, Pittsburgh, Pa., as a sales engineer. He will work out of the company's Philadelphia division office, and his territory will include Baltimore, Md., and the south. He will be associated with E. L. MacWhorter, division manager at Philadelphia. Mr. Mayer previously served as commercial research engineer for the Reading Iron Company.

◆

AT A RECENT reorganization of The Dayton Manufacturing Company, Dayton, Ohio, the following officers were elected: H. D. Hendrick, president and general manager; H. E. Knoll and E. W. Mink, vice-presidents, all located at Dayton. T. R. Sullivan, eastern sales manager, New York City, has also been elected a vice-president, and a new office has been opened in the Transportation building, Chicago, with Floyde Lego in charge.

◆

THE ARMSTRONG BROS. TOOL COMPANY, Chicago; the Apex Tool & Cutter Company, Shelton, Conn.; the Pratt & Whitney Company, Hartford, Conn.; the Davis Boring Tool Division of the Larkin Packer Company, St. Louis, Mo.; the Wendt-Sonis Drill Works, Hannibal, Mo.; the Cole Carbide Industries, Detroit, Mich., and the Genesee Tool Co., Inc., Fenton, Mich., have signed dealer contracts with the Vascoloy-Ramet Corporation, North Chicago, Ill.

◆

MANNING, MAXWELL & MOORE, INC., Bridgeport, Conn., has appointed nine new field salesmen in territories as follows: Paul Hayden, Charlotte, N. C.; W. H. Kissam, Jacksonville, Fla.; R. F. Heath, New Orleans, La.; K. W. Johansson, Minneapolis, Minn.; W. S. Adams, Columbus, Ohio; V. W. Farris, New York; H. H. Jones, Philadelphia, Pa.; H. B. Stallings, Chicago, and C. W. Velie, Tulsa, Okla. The new district sales managers were also appointed: R. W. Neel, who has represented the company for a number of years is now in charge of the newly created southeastern district, with headquarters at Atlanta, Ga., and Malcolm Black, has been appointed manager of the southwestern district, with headquarters at Tulsa.

◆

THE AMERICAN BRAKE SHOE & FOUNDRY CO., New York, has organized the Brake Shoe & Castings Division with its own group of officers, as follows: M. N. Trainer, president; F. P. Biggs, E. V. Smith, W. H. Winters and C. P. Wright, vice-presidents; J. T. Talbot, assistant to president. This division will engineer, produce and market all products formerly handled as The American Brake Shoe & Foundry Co. William B. Given, Jr., is president of The American Brake Shoe & Foundry Co., which is now composed of the following divisions: Brake Shoe & Castings, American Brakeblok, American Forge, American Manganese Steel, Ramapo Ajax, Southern Wheel.

F. P. Biggs was born in 1891 and has been with The American Brake Shoe & Foundry Co. since October, 1916, except during the World War, when he served as an army pilot in the United States Air Corps. In 1921 he was transferred to the western sales department of The American Brake Shoe & Foundry Co., as a salesman, and since January, 1934, served as assistant vice-president in charge of western sales. Edward Barrett Smith began his business career at the time of the formation of The American Brake Shoe & Foundry Co. For many years, he specialized in the sale of brake shoes and castings and miscellaneous products of the company. Since 1928, he served as assistant vice-president. J. T. Talbot was born in 1896, and was employed by the Baltimore & Ohio from 1913 to 1920 as special apprentice, locomotive inspector and gang foreman. He served two years overseas in the 19th Railway Engineers. In June, 1920, he entered the employ of The American Brake Shoe & Foundry Co. as sales representative, serving in that capacity until his recent promotion.

◆

THE VASCOLOY-RAMET CORPORATION, North Chicago, Ill., has made the following additions to its sales engineering staff: George M. Mencke, sales manager; James A. Fraser, assistant sales manager; A. M. Kebe, district manager of the Cleveland, Ohio, territory; C. M. Grannis, district manager of the Detroit, Mich., territory; C. W. Blade, district sales manager of the New England territory; Walter J. Dennis, die sales engineer in the western territory, with headquarters at Chicago; M. W. Dennis, Jr., die sales engineer in the eastern territory, with headquarters at Pittsburgh, Pa., and S. A. Miniea, sales engineer in the Chicago territory. Mr. Mencke was formerly with Thomas Prosser & Sons and later with the Carboloy Company, Messrs. Fraser, Kebe, Grannis, Blade and M. W. Dennis were formerly with the Vanadium-Alloys Steel Company. Walter J. Dennis was formerly with the Illinois Tool Works.

Obituary

CHARLES F. MICHAEL, founder and president of the Ohio Locomotive Crane Company, Bucyrus, Ohio, died on May 4.

◆

WILLIAM F. KINGSTON, who resigned as vice-president of the American Car & Foundry Co., in 1925 and who since has been president of the Lake Erie Tobacco Company, Thomas, Ont., died in St. Louis, Mo., on June 6, of complications, while on a business trip.

◆

J. L. RANDOLPH, who retired as vice-president of the Franklin Railway Supply Company, with headquarters at Chicago, in 1934, died at St. Anthony's Hospital, Rockford, Ill., on June 14 after an extended illness. He retired after 25 years of service with the company.

◆

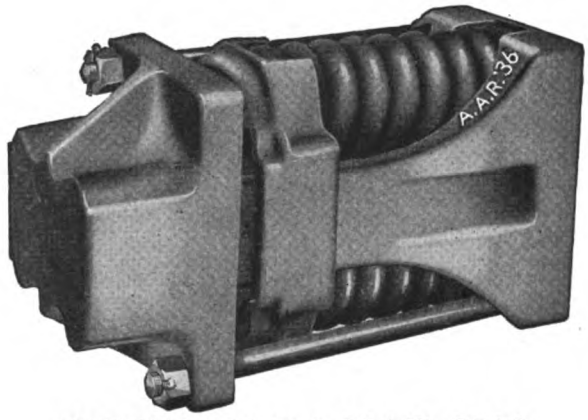
JOHN D. MCCLINTOCK, manager of the injector division of William Sellers & Co., Inc., Philadelphia, Pa., died on June 4, following a six weeks' illness. Mr. McClintock became affiliated with William Sellers & Co., Inc., on April 11, 1881. He was appointed manager of the injector division in January, 1929.

(*Continued on next left-hand page*)

Meet All Requirements

NATIONAL FRICTION DRAFT GEARS

Approved By Association of American Railroads

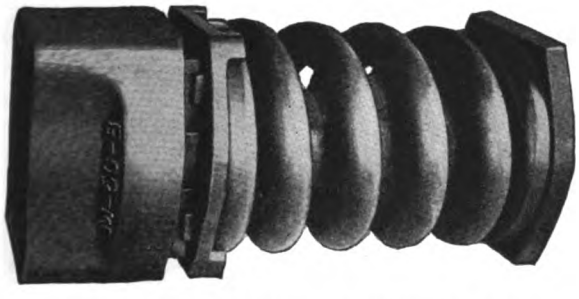


NATIONAL M-17-A DRAFT GEAR
22⅜" long

PROTECTION of cars and lading from destructive shocks incident to modern high speed service is accomplished ideally by National Friction Draft Gears.

They possess all necessary requisites — capacity — sturdiness — endurance — smoothness and uniformity of action that makes them the logical choice for your cars.

With car loadings steadily increasing, it is essential that all available freight equipment be ready for instant use. Equip them with the required type of National Friction Draft Gears and they will continue to give dependable trouble-free service for the life of the equipment.



NATIONAL M-50-B DRAFT GEAR
20⅛" long

NATIONAL MALLEABLE AND STEEL CASTINGS CO.
General Offices: CLEVELAND, OHIO
Sales Offices: New York, Philadelphia, Chicago, St. Louis, San Francisco.
Works: Cleveland, Chicago, Indianapolis, Sharon, Pa., Melrose Park, Ill.

Personal Mention

General

GEORGE R. WILLIAMS, road foreman of engines on the Union Pacific, has been promoted to fuel engineer, with headquarters at Omaha, Neb., succeeding G. H. Likert, who retired on June 1.

FRANK G. FOSTER, superintendent of shops, Canadian National at Leaside, Ont., has been appointed superintendent of motive power and car equipment of the Temiskaming & Northern Ontario, with headquarters at North Bay, Ont.

N. M. TRAPNELL, mechanical engineer of the Chesapeake & Ohio, has been appointed assistant to superintendent of motive power, with headquarters at Richmond, Va. The position of mechanical engineer, also the position of electrical and shop engineer formerly held by the late G. W. Bebout, have been abolished.

F. C. HOLTON, mechanical engineer of the Virginian at Princeton, W. Va., has been appointed assistant superintendent motive power, with the same headquarters. Mr. Holton was born on December 19, 1896, at Danville, Va., and was educated at Danville Military Institute, Danville, 1913; Virginian Polytechnic Institute, B.S., 1917; Cornell University, M.E., 1918. He entered railroad service on June 1, 1912, with the Southern as machinist apprentice at Danville and held a similar position on the Norfolk & Western at Roanoke, Va., during the summer months of 1913 to 1917. Mr. Holton served as machinist, test department, of the Norfolk & Western at Roanoke from June 1, 1919, to May 1, 1920, when he became mechanical inspector of the Virginian at Princeton. On January 1, 1924, he was appointed chief draftsman and on November 15, 1927, became mechanical engineer at Princeton.

JOHN WILHAM SASSER, superintendent of motive power of the Virginian at Princeton, W. Va., at his own request, has been relieved of the duties of that position and has been appointed consulting superintendent motive power, with headquarters at Norfolk, Va. Mr. Sasser was born on April 14, 1877, at Raleigh, N. C., and entered railroad service on December 5, 1892, with the Raleigh & Gaston and Raleigh & Augusta (now part of the Seaboard Air Line), as a machinist apprentice. In 1899 he went with the Atlantic Coast Line as a machinist, later becoming enginehouse foreman. In 1900 he returned to the Seaboard Air Line as a machinist at Raleigh, later becoming erecting shop and enginehouse foreman there. In November, 1901, he became enginehouse foreman of the Atlantic Coast Line at Rocky Mt., N. C., and later served as erecting shop foreman and enginehouse foreman before going to Raleigh as general foreman. In 1908 Mr. Sasser became master mechanic of the old Savannah, Americus & Montgomery, and on April 1, 1911, was appointed master mechanic of the Seaboard Air Line at Jacksonville, Fla. He was appointed superintendent motive power of the Norfolk Southern in 1913 and on December 31, 1920, went to Princeton, W. Va., as superintendent motive power of the Virginian. In January, 1938, his headquarters were transferred to Norfolk, and on June 1, because of ill health, he was appointed consulting superintendent motive power at Norfolk.

GEORGE THOMAS STRONG, who has been appointed superintendent motive power of the Virginian, with headquarters at Princeton, W. Va., as reported in the June issue of the *Railway Mechanical Engineer*, was born on December 22, 1883, at Clifton Forge, Va., and entered railroad service on January 8, 1902, with the Chesapeake & Ohio. After the completion of his apprenticeship he entered the service of the Norfolk & Western at Bluefield, W. Va., as a machinist, from which position he resigned on July 28, 1910, to go with the Virginian. Mr. Strong then served successively as machinist, erecting shop foreman, machine shop foreman, wheel and rod shop foreman, erecting shop foreman, and general foreman for the Virginian. From February 1, 1923, to May 31, 1936, he was master mechanic of the New River division of the Virginian, then becoming general master mechanic. On April 20, 1937, he was appointed assistant superintendent motive power.

Master Mechanics and Road Foremen

THOMAS R. ROSS, master mechanic of the Canadian National, at Leaside, Ont., has been retired from active service after 33 years with the road.

A. MACDONALD has been appointed master mechanic of the Hornepayne division of the Canadian National, with headquarters at Hornepayne, Ont., succeeding J. Hawkins.

J. HAWKINS has been transferred as master mechanic to the Allandale division of the Canadian National, with headquarters at Allandale, Ont., succeeding W. G. Strachan.

A. MILLER, assistant trainmaster of the Ft. Wayne division of the Pennsylvania has been advanced to trainmaster-road foreman of engines of the Toledo division, with headquarters at Toledo, Ohio.

H. SAMUELS, road foreman of engines, Chicago Terminal division of the Pennsylvania, has been appointed road foreman of engines of the Chicago Terminal and Logansport divisions, with headquarters at Chicago.

F. O. FERNSTROM, enginehouse foreman of the Chicago, Milwaukee, St. Paul & Pacific, at Milwaukee, Wis., has been appointed division master mechanic of the Hastings and Dakota division, with headquarters at Aberdeen, S. D., to replace A. M. Martinson.

J. D. SCOTT, road foreman of engines of the Logansport division of the Pennsylvania, has been promoted to trainmaster-road foreman of engines of the Grand Rapids division, with headquarters at Grand Rapids, Mich.

B. W. JOHNSON, assistant road foreman of engines of the New York Division of the Pennsylvania, has been appointed assistant road foreman of engines of the Baltimore Division, with headquarters at Washington, D. C.

A. M. MARTINSON, division master mechanic of the Hastings and Dakota division of the Chicago, Milwaukee, St. Paul & Pacific at Aberdeen, S. D., has been transferred to the La Crosse and River division, with headquarters at La Crosse, Wis., succeeding F. P. Miller, who retired on June 1.

JOSEPH P. BECKER, who has been appointed master mechanic of the Chicago Great Western at Oelwein, Iowa, as noted in the May issue of the *Railway Mechanical Engineer*, was born on December 5, 1888, at St. Paul, Minn. He attended the Oelwein public school and took a course in mechanical engineering at Iowa State College. He entered the service of the Chicago Great Western in June, 1906, becoming a machinist apprentice on August 1 of that year. He subsequently served as a machinist, draftsman, assistant machine shop foreman, gas engine foreman, efficiency engineer and apprentice instructor, production supervisor, and assistant mechanical engineer. He became general locomotive and boiler inspector on October 10, 1936, and master mechanic on May 1, 1938.

Car Department

CHARLES BATTLEY, air brake inspector of the Canadian National at North Bay, Ont., has been retired.

WILLIAM M. MACMILLAN, car foreman of the Canadian National at North Bay, Ont., has been retired.

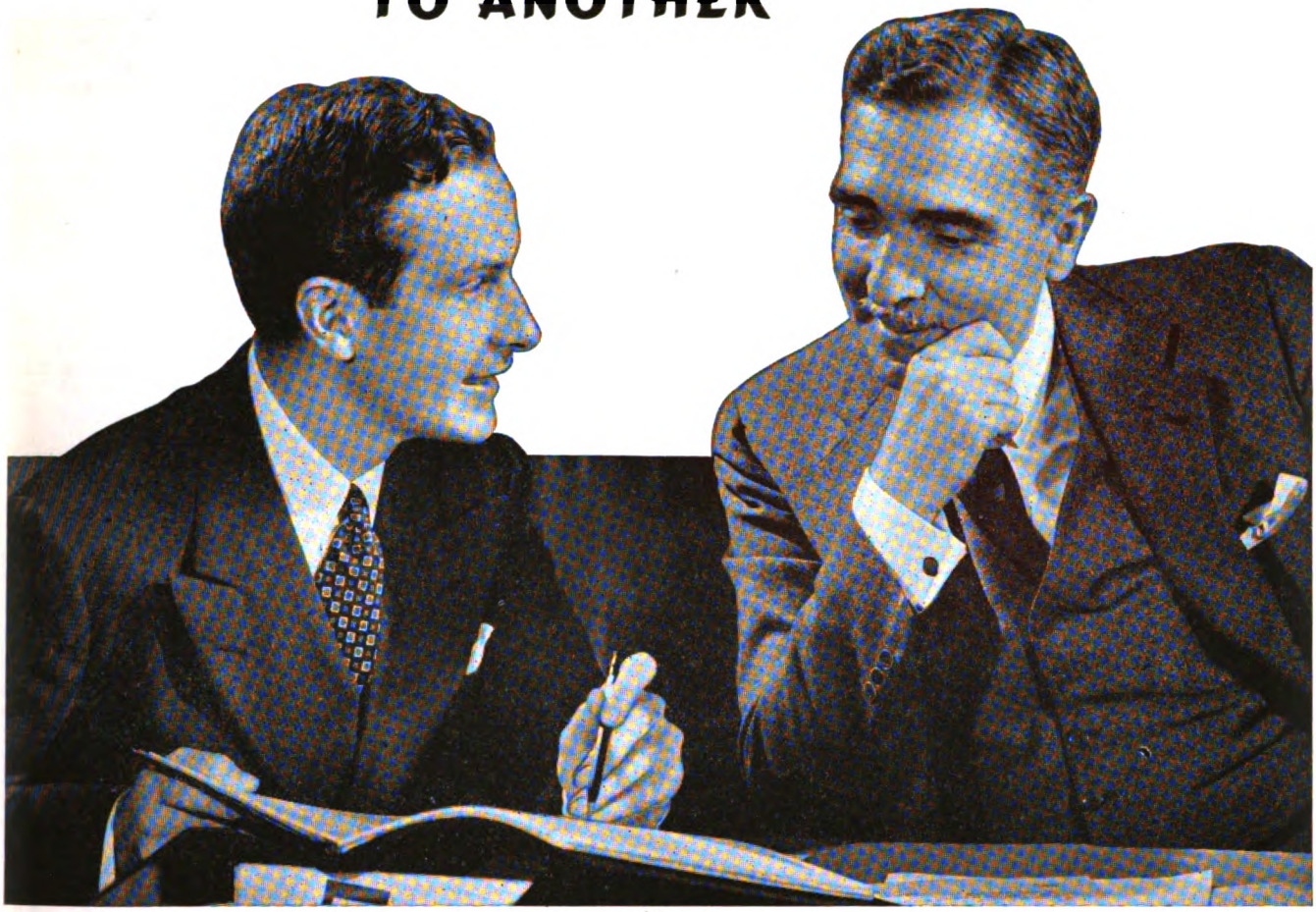
J. B. DUNLOP has been appointed superintendent car shop, Canadian National, with headquarters at Leaside, Ont., succeeding F. G. Foster.

M. E. FITZGERALD, general car inspector of the Chicago & Eastern Illinois at Chicago, has been promoted to the position of master car builder, succeeding to the duties of C. J. Wymer, superintendent of car department, who retired on July 1.

Mr. Fitzgerald was born at Boston, Mass., on March 5, 1886. He entered railroad service in 1901 in the car building and repair shops of the Merchants Dispatch Transportation Co., in East Rochester, N. Y., and subsequently worked as a car builder in the contract shop of the Pressed Steel Car Co., at Butler, Pa., the Standard Steel Car Co., at McKees Rock, Pa., and

(*Continued on next left-hand page*)

AS ONE SPECIALIST TO ANOTHER



YOU ARE a specialist in heavy machinery. You couldn't suddenly start to repair watches instead of railway equipment in your shop, any more than you could move a skilled lathe hand to the foundry and expect him to do expert work. You know *your job* and do it well.

Our job is cleaning. WYANDOTTE Technicians and Service Representatives have qualified as experts in metal cleaning through practical experience. And our products are designed the same way — to do a special job and do it well.

As one specialist to another, we invite you to bring your tough cleaning jobs to us. We have the products and we have the men who know they can be used efficiently and economically. Personal service is always available to you — without obligation, naturally.

THE J·B·FORD COMPANY
WYANDOTTE MICHIGAN
DISTRICT OFFICES IN 27 CITIES

the Pullman Car Co. at Chicago. In 1908 he went with the Gulf, Colorado & Santa Fe as a car repair man at Cleburne, Tex., and in 1909 became car foreman. In 1913 Mr. Fitzgerald left the G. C. & S. F. to



Martin E. Fitzgerald

go with the C. & E. I. as car foreman at Danville, Ill., and in 1914 was promoted to general car inspector.

Shop and Enginehouse

EMIL G. RINGBERG, mechanical engineer of the Boston & Maine, with headquarters at North Billerica, Mass., has been appointed superintendent of the road's repair shops at Concord, N. H., to succeed the late A. H. Anderson.

Purchasing and Stores

J. F. CLEMENTS, assistant purchasing agent of the Akron, Canton & Youngstown and the Northern Ohio, has been promoted to purchasing agent, succeeding Karl H. Suder. The position of assistant purchasing agent has been abolished.

M. W. FARRELL has been appointed division storekeeper of the Saratoga and Champlain divisions of the Delaware & Hudson, with headquarters at Colonie, N. Y., succeeding O. J. Lapaugh, who has been assigned to other duties.

C. I. CASWELL, division storekeeper of the Delaware & Hudson at Plattsburg, N. Y., has been appointed assistant division storekeeper, Saratoga and Champlain divisions, with headquarters at Colonie. The office of division storekeeper, Champlain division, has been abolished.

WARREN W. KELLY, chief engineer of the Western lines of the Atchison, Topeka & Santa Fe, at Amarillo, Tex., has been promoted, effective July 1, to general purchasing agent of the Santa Fe system, with headquarters in Chicago, succeeding J. J. Conn, who died on April 28.

Obituary

CHARLES PETERSON, master mechanic of the Denver & Salt Lake, with headquarters at Denver, Colo., died on June 29, following an operation.

ARCHIBALD M. WATT, former master mechanic of the British Columbia division of the Canadian National, with headquarters at Prince George, B. C., died on May 25. Mr. Watt was 65 years old and had retired about a year ago after 46 years of service.

J. T. CONNOR, who retired as superintendent of the Texas & New Orleans shops at Houston, Tex., in February, 1932, died at his home in Ennis, Tex., on May 30. Mr. Connor was born in Houston on December 17, 1865. At the age of 14 he became a machinist apprentice in the employ of the Houston & Texas Central which has since been merged into the present Southern Pacific system. He subsequently served as a machinist, enginehouse foreman, general shop foreman, assistant superintendent of motive power, superintendent of motive power and machinery, and assistant general manager of motive power and car departments. He was appointed shop superintendent at Houston in 1927.

M. B. MCPARTLAND, general superintendent of motive power of the Chicago, Rock Island & Pacific, with headquarters at Chicago, died suddenly at St. Louis on June 10. Mr. McPartland was born at Burlington, Iowa, on October 3, 1882, and graduated from Purdue University in 1905. He began railway service as a special apprentice on the Chicago, Burlington & Quincy in 1905, and in 1907, went with the New York Central as gang foreman in the West Albany, N. Y., shops. Two years later he became a draftsman on the Rock Island, and in 1910 he went with the National Railways of Mexico as mechanical engineer, returning to the Rock Island in 1913 as general foreman in the mechanical department at Cedar Rapids, Iowa.



M. B. McPartland

Two years later he was transferred to the 47th street shops, Chicago, and after a short time in this position he was promoted to the position of master mechanic at Goodland, Kan. In 1917 Mr. McPartland left the Rock Island to become master mechanic of the Denver & Salt Lake, later being promoted to superintendent of motive power of that road. In 1921 he became superintendent of motive power of the Western Pacific, returning to the Rock Island on June 15, 1936, as general superintendent of motive power.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

WELDERS. — Hobart Brothers, Hobart Square, Troy, Ohio. Bulletin illustrates new model Multi-Range dual control arc welders.

◆

FORGING PRESS.—The Ajax Mfg. Co., Euclid P. O., Cleveland, Ohio. Bulletin 75; 4-page leaflet. Illustrates and describes 1,000-ton solid frame forging press.

◆

RADIAL THRUST ROLLER BEARINGS.—Shafer Bearing Corporation, 35 E. Wacker Drive, Chicago. 74-page catalog. Radial thrust roller bearings and self-aligning ball- and roller-bearing units for industrial and machine applications. Engineering data.

◆

VALVES.—Gold Car Heating & Lighting Co., 220 Thirty-sixth street, Brooklyn, N. Y. Bulletin No. 10. Introducing new pressure reducing and regulating valves, starting valves, and end train pipe valves in the larger sizes for railway, marine and industrial service.

◆

PIPE TOOLS.—Beaver Pipe Tools, Inc., 310 Dana street, Warren, Ohio. Eight-page bulletin descriptive of a new (Model B) ⅛-in. to 2-in. pipe and bolt machine which may be purchased complete or in units. Also a four-page price list of Beaver pipe tools.

◆

BLUEPRINT PAPERS.—Keuffel & Esser Co., Hoboken, N. J. 11-page booklet, "Series Sixty Blueprint Papers." Papers described have an unusually deep blue color and an extremely wide printing range, and produce blueprints said to be as easy to read as the original drawings. List prices.

◆

VALVES, FITTINGS, TOOLS.—Walworth Company, Inc., 60 East 42nd street, New York. Catalog 89; 602 pages; illustrated. Lists and describes complete line of Walworth valves, fittings, pipe and tools, with sections on A. A. R. bronze globe and angle valves; and A. A. R. malleable iron fittings, and A. A. R. unions and union fittings. Engineering data.

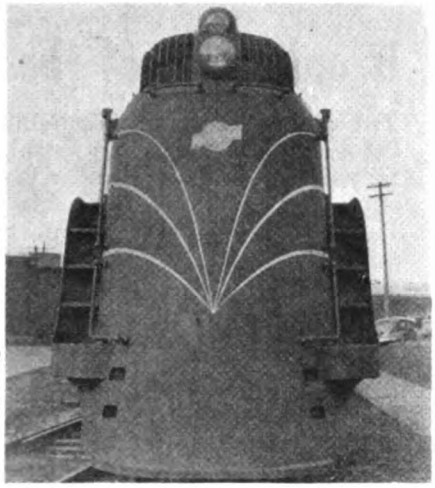
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ELECTRODES.—Page Steel and Wire Division of American Chain & Cable Co., Inc., Monessen, Pa. Twelve-page bulletin. Describes and illustrates the Page-Hi-Tensile G electrode for flat and positioned fillet and general flat welding. Suitable for use with either motor generator or transformer type machines.

RAILWAY MECHANICAL ENGINEER

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.



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August, 1938

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MATERIAL

is only part of the cost

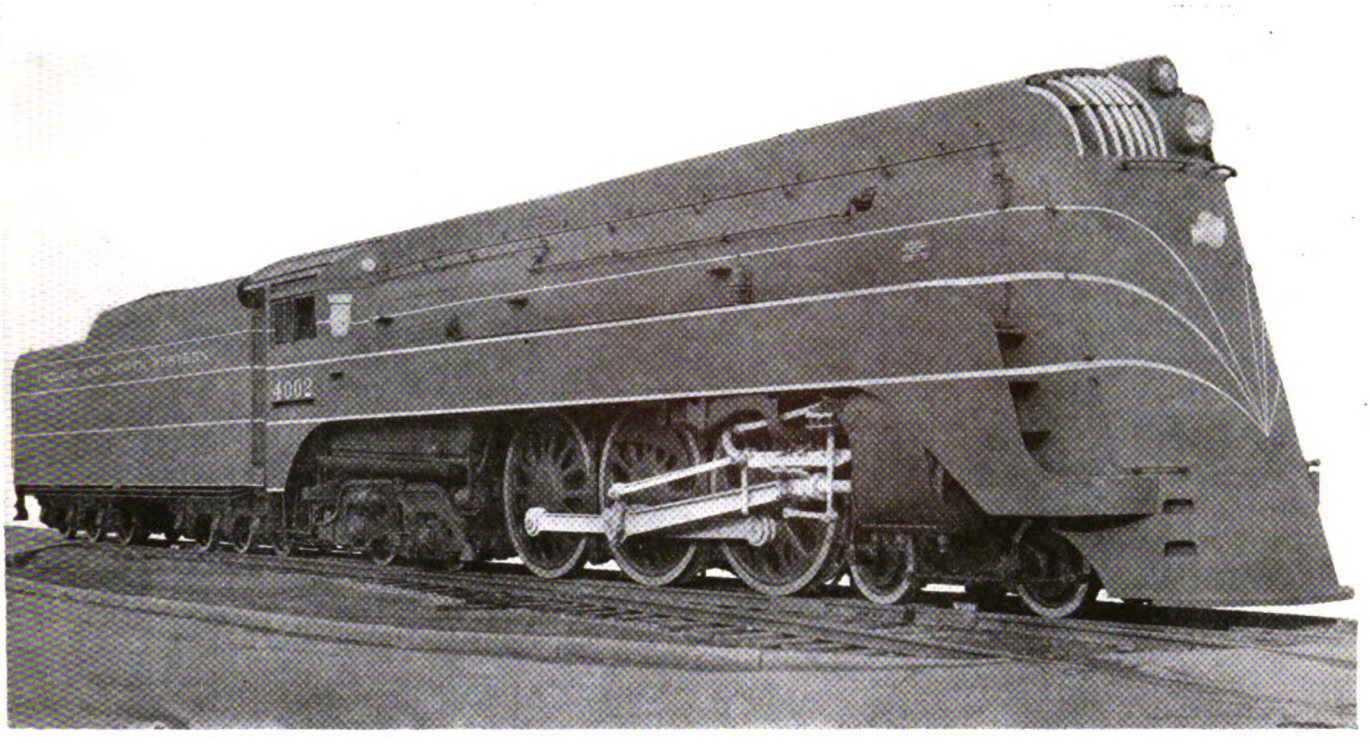
Two pieces of steel, one Republic Alloy Steel and one ordinary steel, when forged and turned into axles look identical—it might be impossible to tell them apart. » » » They both cost the same for labor of forming—Republic costs just a few cents more for material. » » » But the Republic Alloy Steel axle has higher strength and toughness and greater fatigue resistance that gives it longer life, greater resistance to wear and correspondingly lower maintenance costs. » » » Republic Alloy Steel used for crankpins, rods, axles, engine bolts and other highly stressed parts safeguards locomotive performance, minimizes idle time for maintenance and insures maximum locomotive earning capacity. » » » In addition Republic makes many other money-saving materials for railroad use, including Toncan* Iron pipe and sheets, Electrunite* boiler tubes and Upson track materials. Address Department RA, Republic Steel Corporation. General offices: Cleveland, Ohio; Alloy Steel Division: Massillon, Ohio. » » » »

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Chicago & North Western Installs

Heavy 4-6-4 Locomotives

Streamline passenger power weighs 412,000 lb. and has a tractive force of 55,000 lb. — All wheels equipped with roller bearings

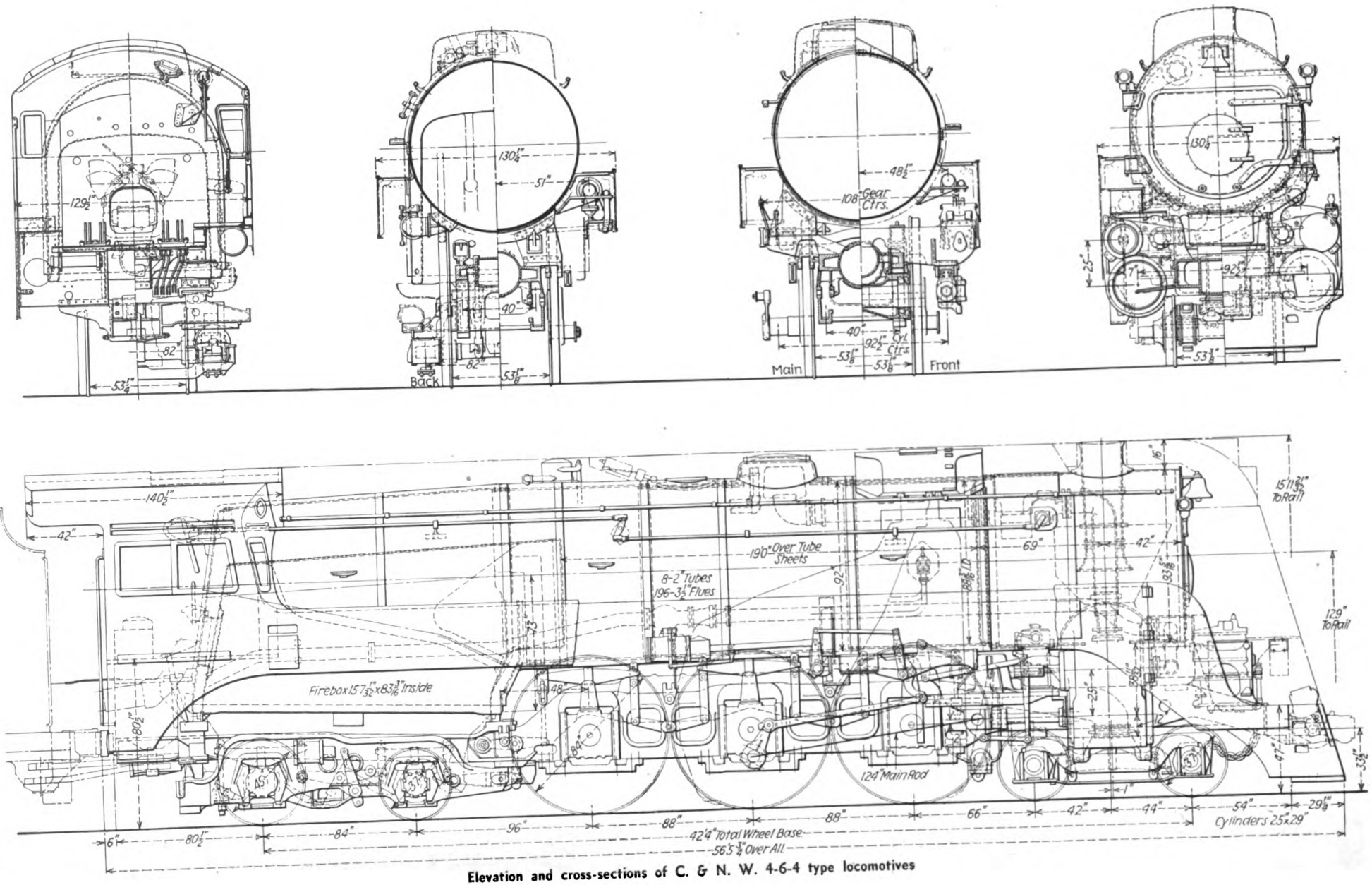
In March and April of this year the American Locomotive Company completed at its Schenectady, N. Y., plant nine streamline 4-6-4 heavy passenger locomotives for service on the Chicago & North Western between Chicago and Omaha, Neb., a distance of 488 miles. These nine locomotives are assigned to the hauling of eight trains, with one locomotive in reserve, and are daily handling from 10 to 17 conventional passenger and Pullman cars on regular runs.

These locomotives are among the largest of the type built to date. They have a weight on drivers of 216,000 lb., a total engine weight of 412,000 lb. and a total engine and tender weight of 772,000 lb. The boilers have a combined evaporative and superheating surface of 5,863 sq. ft. and carry 300 lb. pressure. The tenders are carried on six-wheel trucks and have a coal and water capacity of 25 tons and 20,000 gallons, respectively.

The Boiler

The barrel of the boiler is in three courses, the inside diameter of the first course being $88\frac{3}{16}$ in., the second $90\frac{1}{16}$ in., and the third 92 in. The thickness of the plate of the first course is $\frac{15}{16}$ in., the second $\frac{31}{32}$ in., and the third 1 in. Nickel steel, furnished by the Bethlehem Steel Company, is used for the shell-course plates, welt strips and liners. The dome and safety-valve turret opening is located in the second course. The dome is $40\frac{1}{2}$ in. inside diameter and is flanged from a single piece of plate. The front tube sheet is $\frac{3}{4}$ in. thick and the back tube sheet $\frac{9}{16}$ in. The firebox is $157\frac{1}{32}$ in. long inside and $83\frac{3}{16}$ in. wide inside. The combustion chamber is 31 in. in length. The firebox is arranged for bituminous coal, using pin-hole type, cast-iron rocking grates.

The roof sheet is of nickel steel furnished by Bethlehem, while all the rest of the flanged sheets in the firebox and combustion chamber are of Lukens open-hearth steel. The roof sheet is $\frac{13}{16}$ in. thick, while the outside side sheets are $\frac{9}{16}$ in. thick. All of the inside firebox sheets



Elevation and cross-sections of C. & N. W. 4-6-4 type locomotives

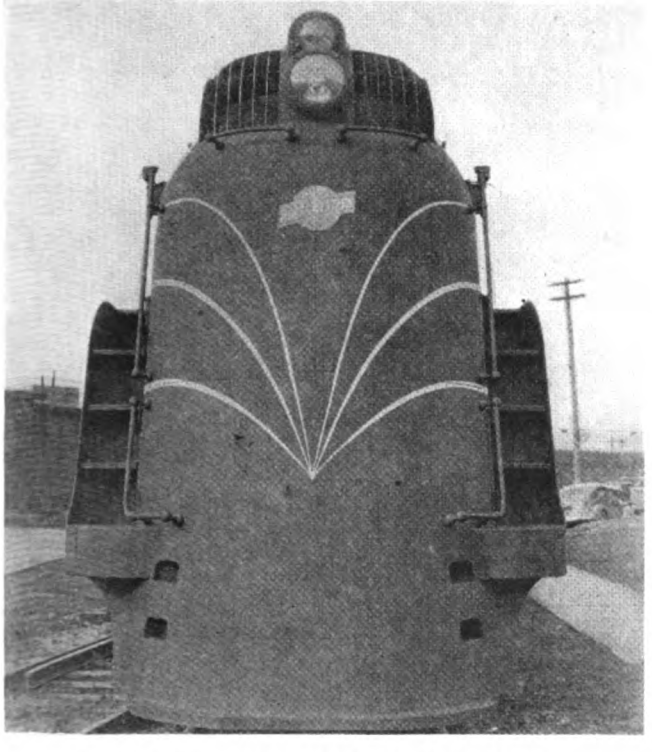
are $^{13}/_{32}$ in. thick. The water space at the mud ring is 5 in. at the sides and rear and 5½ in. at the front.

Welding has been used on the inside throat sheet and back tube sheets. Sealing welds have been used at the back mud-ring corners of the firebox to a height of 10 in. from the bottom of the mud ring. The fire-door

C. & N. W. 4-6-4 Locomotives Compared with Others of the Same Type Recently Built

Road	C. & N. W.	N. Y. C.	A. T. & S. F.	C. B. & Q
Road number	4001	5405	3465	3000
Builder	Alco	Alco	Baldwin	Baldwin
Date built	April, 1938	1937	1937	1930
Tractive force engine, lb.	55,000	43,440	49,300	47,700
Tractive force booster, lb.	.....	12,100	.....	11,700
Weight engine, lb.	412,000	360,000	412,380	391,880
Weight on drivers, lb.	216,000	196,000	213,440	207,730
Cylinders, diam. and stroke, in.	25 x 29	22½ x 29	23½ x 29½	25 x 28
Driving wheels, diam., in.	84	79	84	78
Steam pressure, lb.	300	275	300	250
Grate area, sq. ft.	90.7	82	98.5	87.9
Heating surface, firebox, sq. ft.	507	360	375	369
Heating surface, total evap., sq. ft.	3,979	4,187	4,770	4,247
Superheat. surface, sq. ft.	1,884	1,745	2,080	1,830
Comb. evap. and superheat., sq. ft.	5,863	5,932	6,850	6,077

opening between the back head and inside back firebox sheet has been welded. Welding has also been employed at each end of all longitudinal seams in the shell of the boiler for a distance of 12 in. from the end of the seam. An extensive application of Alco telltale type flexible stays has been made in the fireboxes of these locomotives. Flexible stays using WZ type sleeves have been



The striping meets in a point at the front end

used in the throat sheet and two outside rows of the back head. Flexible radial stays with WZ sleeves have been used extensively in the firebox sides and crown sheet, except where expansion stays are used in the combustion chamber area.

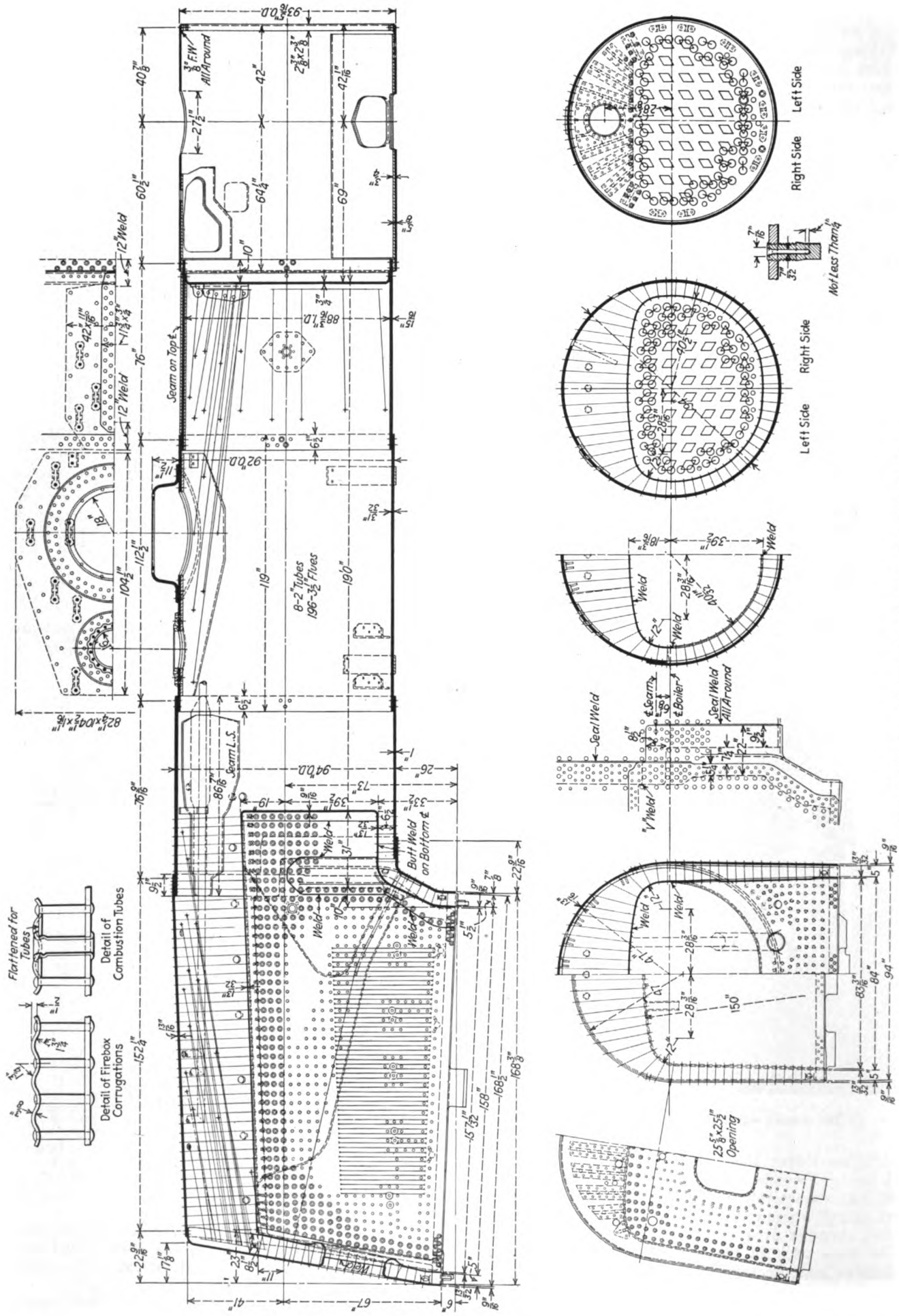
The brick arch in the firebox is supported on two arch tubes and the two Thermic syphons. Four combustion tubes are located in each side of the firebox. The inside firebox side sheets are corrugated between 27 staybolt rows. The corrugations are formed on a radius of 1¾ in. to a total depth from peak to valley of ½ in. Where the combustion tubes pass through the inside firebox the sheet is flattened over a sufficient area to permit beading the tubes. The boilers are equipped with the Barco Type F3a low-water alarm, Superior

General Dimensions, Weights and Proportions of the C. & N. W. 4-6-4 Type Streamline Locomotives

Railroad	C. & N. W.
Builder	American Locomotive Co.
Type of locomotive	4-6-4
Road class	E4
Road numbers	4001-4009
Date built	1938
Service	Passenger
Dimensions:	
Height to top of stack, ft.-in.	15—11$^{11}/_{32}$
Height to center of boiler, ft.-in.	10—9
Width overall, in.	10—9½
Cylinder centers, in.	92½
Weights in working order, lb.:	
On drivers	216,000
On front truck	87,000
On trailing truck	109,000
Total engine	412,000
Tender	360,000
Wheel bases, ft.-in.:	
Driving	14—8
Rigid	14—8
Engine, total	42—4
Engine and tender, total	88—11¾
Wheels, diameter outside tires, in.:	
Driving	84
Front truck	37
Trailing truck:	
Front	37
Rear	45
Engine:	
Cylinders, number, diameter and stroke, in.	2—25 x 29
Valve gear type	Baker
Valves, piston type, size, in.	(7)—12 (2)—14
Maximum travel, in.	7¾
Steam lap, in.	1$^{7}/_{8}$
Exhaust clearance, in.	$^{3}/_{8}$
Lead in full gear, in.	$^{3}/_{16}$
Cut-off in full gear, per cent	72.6
Boiler:	
Type	Straight top and bottom
Steam pressure, lb. per sq. in.	300
Diameter, first ring, inside, in.	88$^{5}/_{16}$
Diameter, largest, outside, in.	94
Firebox length, in.	157$^{1}/_{16}$
Firebox width, in.	83$^{5}/_{16}$
Height mud ring to crown sheet, back, in.	78
Height mud ring to crown sheet, front, in.	92
Combustion chamber length, in.	31
Arch tubes, number and diam., in.	2—3½
Thermic syphons, number	2
Tubes, number and diam., in.	8—2
Flues, number and diam., in.	196—3½
Length over tube sheets, ft.-in.	19—0
Fuel	Bituminous coal
Stoker	Standard BK
Grate	Rocking type
Grate area, sq. ft.	90.7
Heating surfaces, sq. ft.:	
Firebox	367
Arch tubes	21
Thermic syphons	119
Firebox, total	507
Tubes and flues	3,472
Evaporative, total	3,979
Superheating	1,884
Combined evap. and superheat.	5,863
Tender:	
Type	Rectangular
Water capacity, gal.	22,000
Fuel capacity, tons	25
Trucks	6-wheel
Rated tractive force, engine, 85 per cent, lb.	55,000
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	52.5
Weight on drivers ÷ tractive force	3.93
Weight of engine ÷ evaporation	105.5
Weight of engine ÷ comb. heat. surface	7.03
Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	86.7
Tube-flue heat. surface, per cent comb. heat. surface	59.25
Superheat. surface, per cent comb. heat. surface	32.15
Firebox heat. surface ÷ grate area	5.6
Tube-flue heat. surface ÷ grate area	38.3
Superheat. surface ÷ grate area	20.78
Comb. heat. surface ÷ grate area	64.70
Evaporation ÷ grate area	4.42
Tractive force ÷ grate area	607.0
Tractive force ÷ evaporation	13.75
Tractive force ÷ comb. heat. surface	9.39
Tractive force x diam. drivers ÷ comb. heat. surface	788.0

flue blowers and Wilson blow-off cocks and mufflers. The fire door is the Franklin Butterfly type. Fuel is fed by means of a Standard type BK stoker. The stoker engine is located on the tender.

Water is fed to the boilers by means of a 6,500-gallon



Cross sections and elevations of the boiler of the C. & N. W. locomotives

Hancock non-lifting injector on the right side and an Elesco No. 3 exhaust-steam injector on the right side. The saturated steam passes through a Tangential steam dryer in the dome to the Type E superheater and is controlled by an American multiple throttle built into the superheater header.

The ash pans are of steel plate, welded at the joints.

Engine Bed and Running Gear

These locomotives are equipped with the General Steel Castings cast engine bed with cylinders, back cylinder heads, link-support and guide-yoke brackets and air-pump brackets cast integral. The boilers are supported on expansion shoes at all four corners of the firebox. A waist-sheet crosstie is located at the reverse-shaft support and between the second and third pairs of drivers.

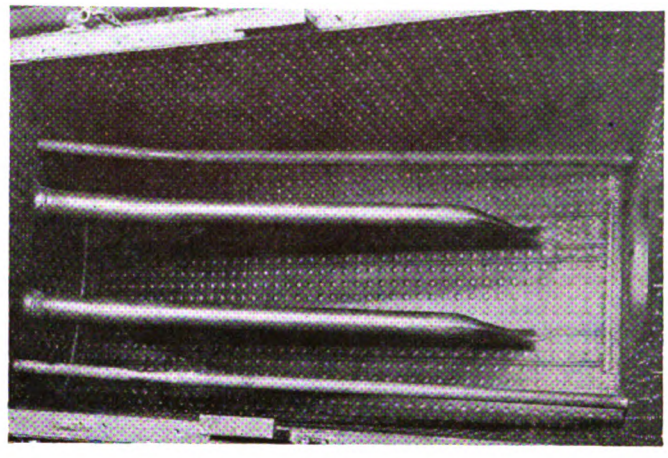
The engine trucks are the General Steel Castings four-wheel type with 37-in. rolled-steel Bethlehem wheels and A. S. F. roller-bearing units. The driving wheel centers are 76 in. in diameter and are the Boxpok type. The driving axles are equipped with Timken roller bearings with one-piece housings. The journal diameter is 13.008 in. at the main wheel and 12.008 in. on the front and back drivers. The diameter of the drivers over the tires is 84 in.

The trailing truck is the four-wheel Delta type furnished by the General Steel Castings Corporation, with 37-in. rolled-steel wheels on the front axle and 45-in. rolled-steel wheels on the rear axle. The wheels were furnished by Bethlehem and the journals are mounted in Timken roller bearings. The diameter of the front trailing-truck journal is 6.254 in. and that of the rear axle 7.004 in. Provision is made in the design of the trailer truck for the future application of a booster.

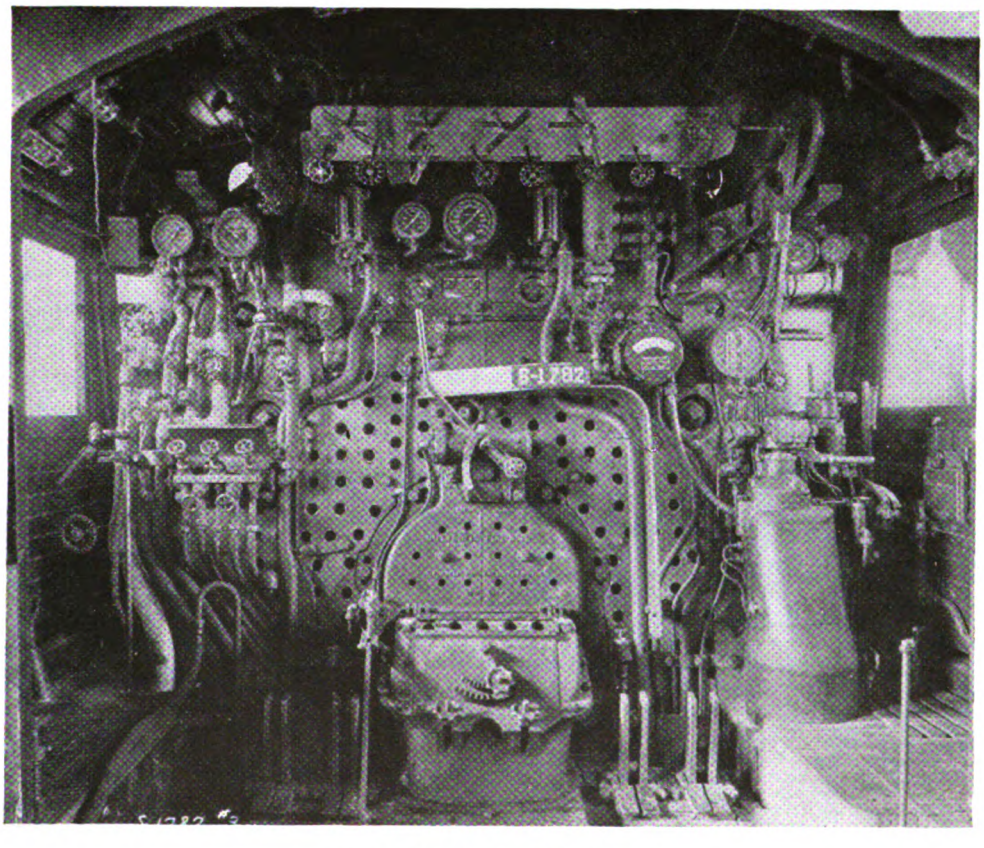
The cylinders are 25 in. by 29 in. and the piston valves on seven of the engines are 12 in. diameter, while the remaining two have 14-in. valves. Cylinders and valve chambers are fitted with Hunt-Spiller gun-iron bushings, piston and valve bull rings and Hunt-Spiller Duplex piston- and valve-packing rings. The piston heads are the Z type, of rolled steel, and the rods are nickel-carbon steel 5 in. in diameter. The multiple-bearing type of crosshead is used. The main and side rods are nickel-carbon steel, normalized, quenched and drawn. Floating type bushings are used both in the main and side rods.

The weight of the reciprocating parts on each side of these locomotives is 1,720 lb. The amount of overbalance at each wheel is 201 lb. and the dynamic augment is 4,910 lb., 8,750 lb. and 13,660 lb. at 60, 80 and 100 m. p. h., respectively. The revolving weights are cross counterbalanced in all wheels.

Steam distribution is controlled by Baker valve gear actuated by a Barco type M-1 power reverse gear mounted on a bracket secured to the boiler shell.



The interior of the firebox



Arrangement of cab and back head

Force-feed lubrication is used on cylinders, valves, guides, valve-rod guides, engine-truck, driving-box and trailer-truck-box shoes, engine-truck center pin and trailer-truck fulcrum. Two Detroit 32-pint lubricators, one of 10 feeds and the other of 16 feeds, are applied on the right and left sides, respectively. Both are driven from the top end of a combination lever. A Nathan six-pint, four-feed hydrostatic lubricator takes care of the air pumps and stoker engine.

The brakes are the Westinghouse Schedule 8-ET. Two 8½-in. cross-compound compressors are mounted on a bracket cast integral with the bed back of the bumper beam. Air reservoirs of 60,000 cu. in. capacity are cast in the bed. Independent brake cylinders are used for driving and trailer brakes. The entire engine brake rigging, as well as the spring rigging, is fitted with Ex-Cell-O pins and bushings.

Piping

An interesting feature of the locomotives is the arrangement of the saturated-steam piping designed to eliminate the cab turret. Just ahead of the front of the cab there are three main steam valves connected to three dry pipes, inside the boiler, from the dome. Two of these are 2½-in. Hancock angle valves, one for the right injector and the other for the exhaust-steam injector on the left side. A third 2½-in. Hancock angle valve feeds into a 2½-in. manifold at the end of which is the steam-heat shut-off valve and pressure regulator. From the manifold itself there are two outlets, one a ¾-in. pipe to the cylinder cocks and the other a 1-in. nipple to a 1-in. by ¾-in. by ½-in. tee in another manifold made up of pipe and fittings. This has four outlets,—two ½-in. connections to the injector and lubricator heaters and two at the opposite end of ¾-in. size to the coal sprinkler and headlight generator. The superheated-steam line to the blowers, air pumps, whistle, coal pusher and smoke consumer, is arranged in the conventional manner with the take-off from the superheater header.

Streamlining

These locomotives are covered with a shroud which was designed to provide a pleasing appearance while, at the same time, offering the least interference with inspection and maintenance. No. 14-gage material has been used on the front end and sides and No. 16 gage on the top cowling. Three red stripes run along the sides of the entire engine and tender, matching similar stripes on the cars, and converge at a point just above the coupler opening.

Except at the rear of the cab and at the front steps over the cylinders, there is no skirt below the tops of the drivers. Motion work parts and the lower part of the firebox and ash pan are exposed for inspection. The front is hinged to provide ready access to smokebox and air pumps. The shrouding at the front of the locomotive is set back of a vertical line through the coupler pulling faces to permit two of these locomotives to be coupled head on.

The Tender

The tender is built up on a Commonwealth cast-steel water-bottom frame with electrically welded steel-plate tank. The tank is 40 ft. long, 10 ft. 6 in. wide and 87 in. deep. The tender-truck wheel base is 11 ft. and the total tender wheel base is 34 ft. 11½ in. The tender trucks are General Steel Castings six-wheel non-swing motion, center-bearing trucks, with cast-steel side frames, Davis cast-steel wheels and Simplex unit cylinder clasp brakes having two brake cylinders per truck. A. S. F. roller-bearing units are used on the tender wheels in combination with outside journal boxes. The tender draft gear is the Miner ASXB with A. S. F. cast-steel yoke and Type E coupler. The Franklin Unit Safety bar is used between engine and tender.

Partial List of Materials and Equipment on the C. & N. W. 4-6-4 Type Streamline Locomotives

Engine bed; engine and trailer trucks	General Steel Castings Corp., Eddystone, Pa.
Engine and trailer-truck wheels	Bethlehem Steel Co., Bethlehem, Pa.
Tires, driving-wheel and others	American Locomotive Co., New York
Driving boxes, roller-bearing	The Timken Roller Bearing Company, Canton, Ohio
Slidguide attachment	American Locomotive Co., New York
Coupler yoke	American Steel Foundries, Chicago
Front coupler	National Malleable and Steel Castings Co., Cleveland, Ohio
Air brake and air signal	Westinghouse Air Brake Co., Wilmerding, Pa.
Driver brake	American Brake Co., St. Louis, Mo.
Brake shoes	American Brake Shoe & Foundry Co., New York
Drawbar, engine and tender	Franklin Railway Supply Co., Inc., New York
Train control	General Railway Signal Co., Rochester, N. Y.
Radial buffer	Franklin Railway Supply Co., Inc., New York
Springs, driving	American Steel Foundries, Chicago
Pins and bushings	Ex-Cell-O Corporation, Detroit, Mich.
Cylinder and piston-valve bushings; piston and valve bull rings; duplex sectional cylinder- and valve-packing rings	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Cylinder cocks	The Prime Manufacturing Co., Milwaukee, Wis.
Valve gear	Pilliod Co., New York
Piston-rod packing	Paxton-Mitchell Co., Omaha, Neb.
Rod brasses	Magnus Metal Div., National Lead Co., New York
Rod fittings	Alemite Div. Stewart-Warner Corp., Chicago
Roller bearings:	
Engine truck	American Steel Foundries, Chicago
Driving and trailer truck	The Timken Roller Bearing Co., Canton, Ohio
Power reverse gear	Barco Manufacturing Co., Chicago
Lubricators:	
Hydrostatic	Nathan Manufacturing Co., New York
Mechanical	Detroit Lubricator Co., Detroit, Mich.
Boiler steel	Bethlehem Steel Co., Bethlehem, Pa. Lukens Steel Co., Coatesville, Pa.
Tubes and flues	Globe Steel Tubes Co., Milwaukee, Wis.
Staybolt iron	Joseph T. Ryerson & Son, Inc., Chicago
Staybolts	American Locomotive Co., New York
Firebox rivets	The Champion Rivet Co., Cleveland, Ohio
Thermic syphon	Locomotive Firebox Co., Chicago
Brick arch	American Arch Co., Inc., New York
Superheater	The Superheater Company, New York
Throttle valve	American Throttle Co., New York
Throttle-rod stuffing-box packing	The Allpax Co., Inc., Mamaroneck, N. Y.
Tangential steam dryer	The Superheater Company, New York
Blow-off cock and muffler	Wilson Engineering Corp., Chicago
Blower valve; steam and air gages; safety valves; back-pressure gages; check valves	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Lagging	Johns-Manville Sales Corp., New York
Pipe covering	Union Asbestos & Rubber Co., Chicago
Live steam injector	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Exhaust steam injector	The Superheater Company, New York
Washout plugs	Huron Mfg. Co., Detroit, Mich.
Stoker	Standard Stoker Co., Inc., New York
Fire door	Franklin Railway Supply Co., Inc., New York
Flue blower	Superior Railway Products Corp., Pittsburgh, Pa.
Grates	American Locomotive Co., New York
Coal sprinker	Wm. Sellers & Co., Inc., Philadelphia, Pa.
Gage holder	Swanson Co., Chicago
Pyrometer	The Superheater Company, New York
Low water alarm	Barco Manufacturing Co., Chicago
Water columns	Sargent Co., Chicago
Steam heating equipment	Vapor Car Heating Co., Inc., Chicago
Steam-heat connections	Barco Manufacturing Co., Chicago
Whistle	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Bell ringer	Railway Service and Supply Corp., Indianapolis, Ind.
Sander	Graham-White Sander Corp., Roanoke, Va.
Headlight and generator	Pyle-National Co., Chicago
Lamps	The Adams & Westlake Co., Elkhart, Ind.
Flexible connections between engine and tender	Barco Manufacturing Co., Chicago
Cab windows	The Prime Manufacturing Co., Milwaukee, Wis.
Tender:	
Water-bottom frame; trucks	General Steel Castings Corp., Eddystone, Pa.
Wheels; springs	American Steel Foundries, Chicago
Bushings	Ex-Cell-O Corporation, Detroit, Mich.
Journal boxes	National Malleable and Steel Castings Co,. Cleveland, Ohio
Journal bearings	American Steel Foundries, Chicago
Clasp brake	American Steel Foundries, Chicago
Dust guards	Geo. O. Jenkins Co., Bridgewater, Mass.
Draft gear	W. H. Miner, Inc., Chicago
Tank	Bethlehem Steel Co., Bethlehem, Pa.
Tank valve	Crane Co., Chicago
Hose	United States Rubber Products, Inc., Passaic, N. J.

Service Failures

By Fred H. Williams
M. Sc., F. R. S. A.

SOME attention was given in the article in the May, 1938, *Railway Mechanical Engineer* to breakages of small crank shafts on hand cars which had been modernized by the application of a gasoline motor drive. Such failures, while they may prove embarrassing, ordinarily do not involve any great amount of expense. Unfortunately, however, similar failures do occur with crank shafts of larger size on Diesel engines which involve considerable sums of money.

An illustration of such a failure is shown in Fig. 1. A fatigue crack started in a rough fillet, the finish of which is made more clear by Figs. 2 and 3, the latter being an enlarged view of the fillet at the point where the fatigue crack started. Shafts of this type cost several thousand dollars apiece and obviously every precaution should be taken to insure a smooth finish in the fillets. The roughness of the finish on the crank-pin arm and in the two fillets is quite clearly shown in Fig. 2. Certainly it does not look well for a high-grade piece of machinery of this sort to wear a coat like a tramp, and yet examples of this kind are encountered only too frequently. It is true that in this case the fillet at the bearing was generously proportioned and fairly well finished, but the fillet about 7/8 in. above the bearing was very rough and of much the same type as that of the broken hand car crank shaft, which was illustrated in the May issue, page 175.

Incidentally, the working drawing called for an "ff" finish and the manufacturer maintained that such a finish had been furnished. It was also inferred that while the railways demand good finishes, they do not make them themselves. This may be true in some instances, and yet such failures drive home the fact that unusual precautions must be taken to insure smooth and high-grade finishes on all important parts. Polished surfaces are essential to the elimination of such failures; rough and torn surfaces are breeders of fatigue cracks and failures.

It can, of course, be argued that with the best of finishes stress-corrosion cracks, such as were discussed in the earlier articles of this series, could occur, and it is quite true that frequently it is impossible to differentiate between stress-corrosion cracks and those caused by tool or score marks. That, however, is no reason why inferior workmanship should be tolerated under any condition. In the case of the crank shaft under consideration there is no question but what the failure was due to rough machining and that stress-corrosion cracks were not present.

While we are considering Diesel-engine crank-shaft failures, it may be well to illustrate a typical case of another sort. In these days of high speed, special efforts are being made to reduce the weight of rotating parts and particularly those of odd shapes. The crank shaft of a six-cylinder Diesel engine is shown in Fig. 4. The crank pins are lightened by drilling a hole about 2½ in.

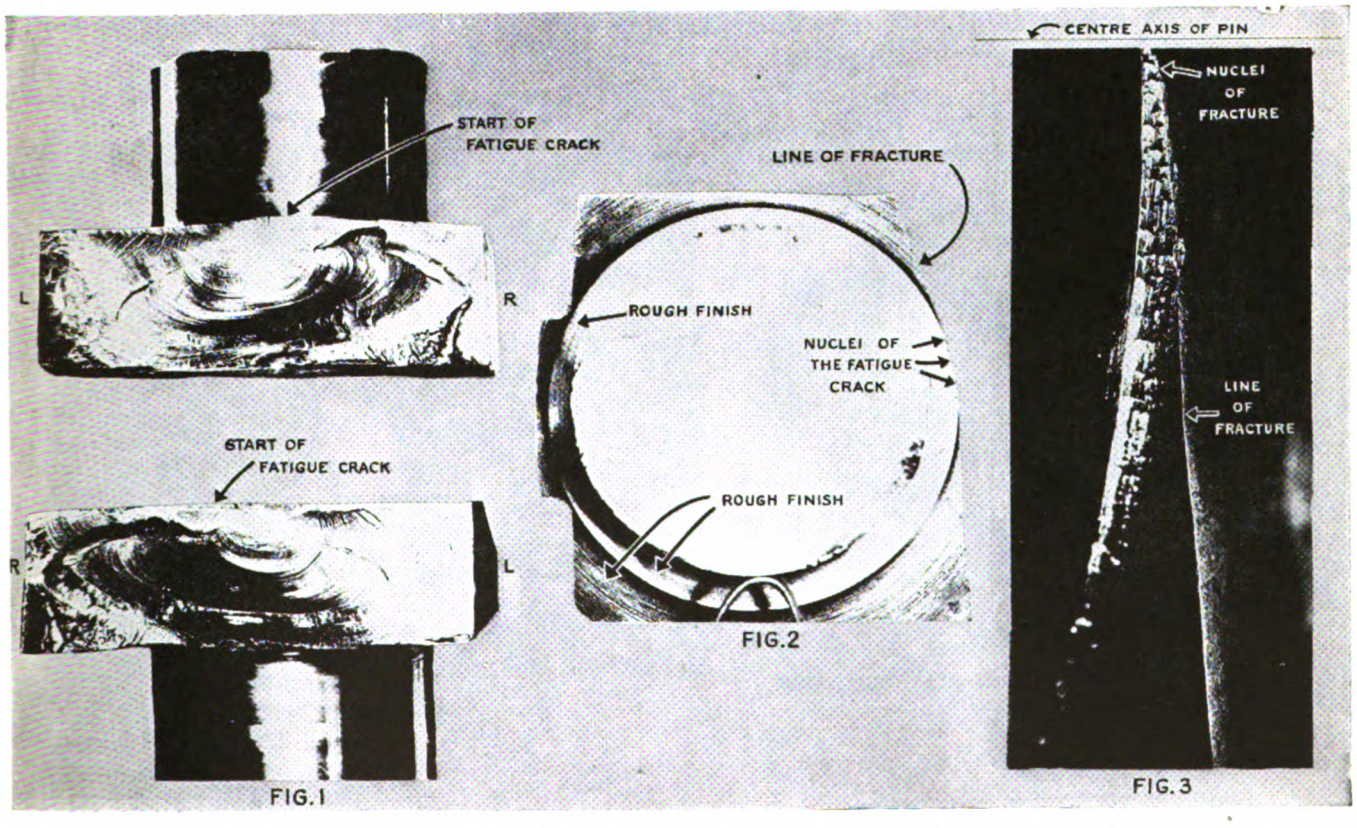


Fig. 1: Fractured faces of broken Diesel engine crank shaft.—Fig. 2: Section through crank pin of large crank shaft.—The fillets at the juncture of the crank pin and crank arm and a short distance away on the crank arm are both rough finished.—Fig. 3: Enlarged view of fillet in which fatigue crack started—designated as "ff" finish by manufacturer of crank shaft

in diameter through each one. Unfortunately, these holes were left in a rough condition and here the trouble started.

Figs. 5 and 6 illustrate a break that started from a crack in the drilled hole through a pin. A secondary fatigue crack is plainly evident in Fig. 6. That it was a fatigue crack is indicated by the fact that its progress is plainly marked, with the typical progressing circular lines. This secondary crack started from a spot in the primary crack, caused either from an inclusion or by a local stress which was set up when the primary crack had progressed beyond its effective range. The secondary crack is an unusually good example of a fatigue crack and indicates how design goes for naught when the machine shop falls down on its job, either by carelessness or by speed in rushing the work through, or a lack of appreciation of the essentials of good finishes and proper fillets and radii.

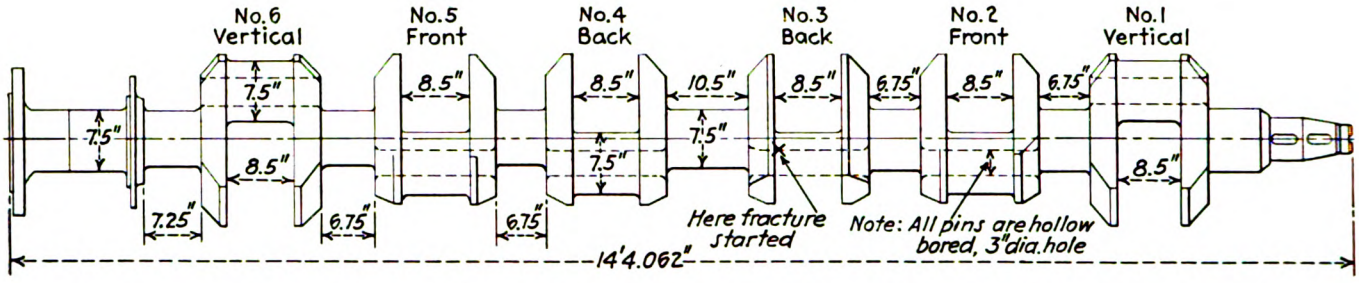


Fig. 4—Six-cylinder Diesel engine crank shaft

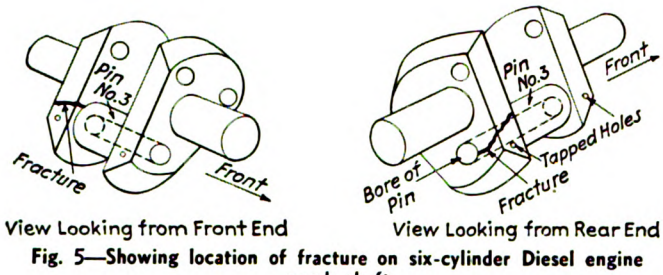


Fig. 5—Showing location of fracture on six-cylinder Diesel engine crank shaft

Another view of the fracture, including a portion of the drilled hole, is shown in Fig. 7. While the surface of the drilled hole is slightly out of focus, it can readily be seen that the finish was rough and crude. This is indicated still more clearly in Fig. 8—another view of the break. It is evident from Fig. 7 that the starting point of the crack was from the bore and not from the surface of the arm. In Fig. 8, the primary crack is shown below the drilled hole and while the finish of this section is a bit indistinct in the photograph, it is quite evident that the fatigue crack started from the bore and radiated outward.

The grave danger of drilling through steel is that the drill may not cut properly and will tear the steel, leaving stressed metal when the hole is finished. The number of failures from drilled holes is very large and such failures will continue as long as precautions are not taken to smooth the drilled walls and relieve any stresses caused

(*Continued on page 296*)

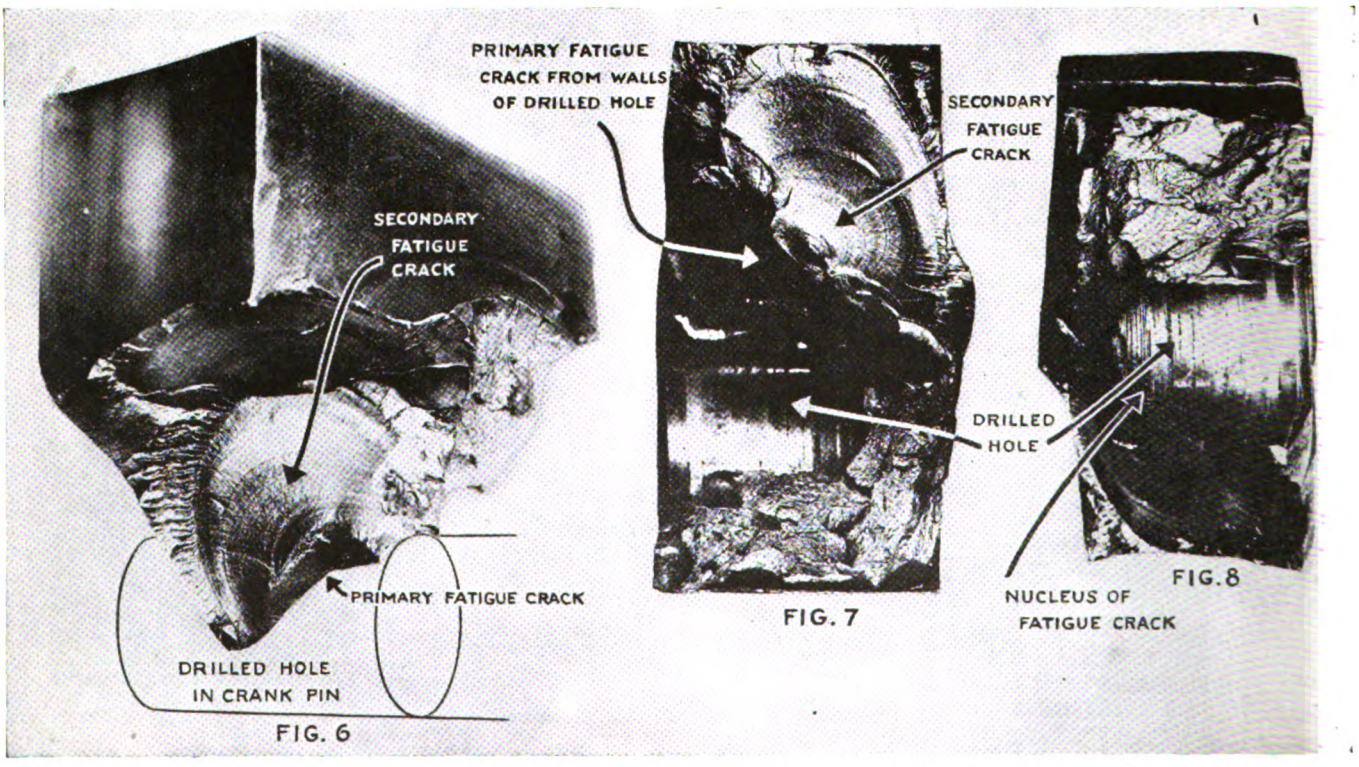
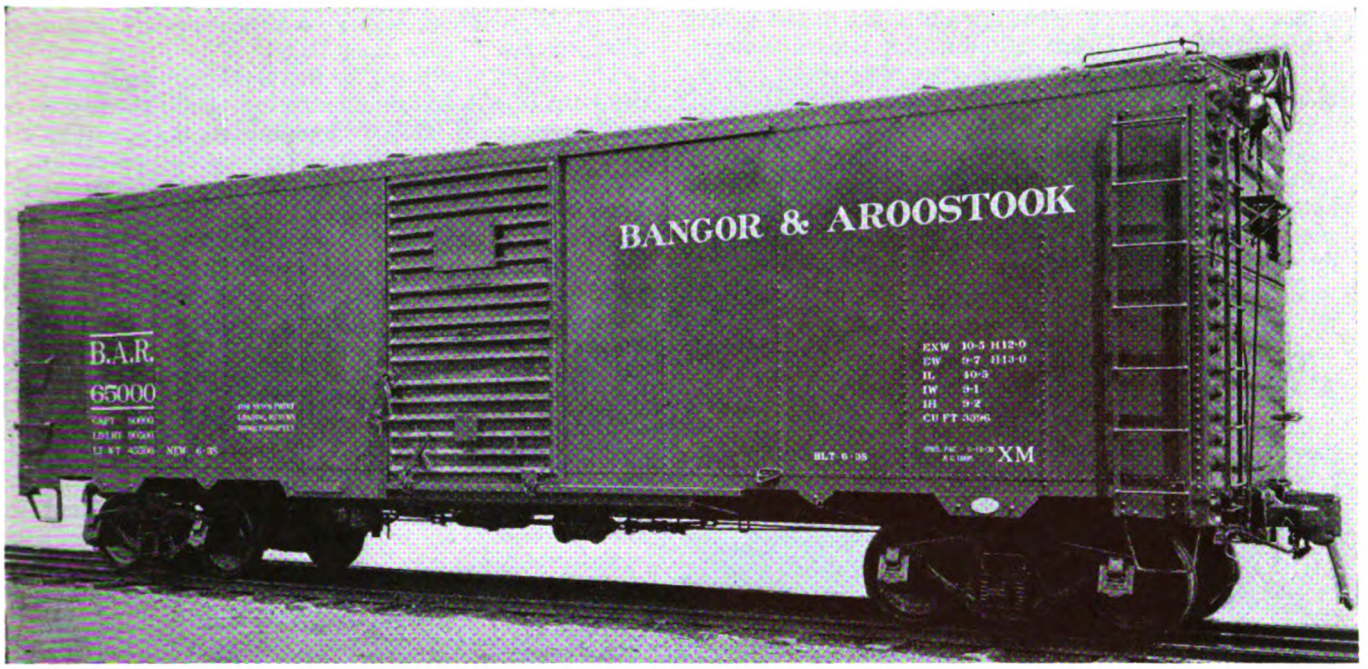


Fig. 6: Portion of fracture of Diesel engine crank shaft showing primary and secondary fatigue cracks.—Figs. 7 and 8: Walls of drilled hole are torn and scored; this caused the failure of the crank shaft



B. A. R. 40-ton steel-sheathed box cars built by the Magor Car Corporation

Special Features for Handling Newsprint Lading Incorporated in

Bangor & Aroostook Box Cars

Magor Car Corporation delivers 500 box cars to the B. A. R. that follow A. A. R. design but have heavy lining, flooring and anchoring features to protect newsprint lading while in transit

THE Bangor & Aroostook recently received from the Magor Car Corporation, New York, 500 steel-sheathed wood-lined 40-ton capacity box cars in the building of which special consideration was given to features which permit handling newsprint lading without damage. Newsprint is shipped in rolls in two sizes; namely, 36 in. in diameter by 68 in. high, weighing between 1,700 and 2,000 lb., and half rolls 29 in. in diameter by 34 in. high, weighing between 850 and 1,000 lb. This commodity requires the utmost care while being handled in transit; damage due to chafing of rolls, shifting of loaded rolls within the car while in transit, and water damage are only a few of the many causes which render it unsuitable for use.

These 40-ton capacity cars have a cubical capacity of 3,396 cu. ft., a light weight of 45,500 lb., a load limit of 90,500 lb., and a ratio of pay load to gross load of 66.5 per cent. The principal proportions of the cars are given in the accompanying table.

Features of Superstructure and Lining

The car superstructure follows A. A. R. recommended practices. The roof, of Chicago-Hutchins type, is of solid galvanized steel and has compression riveted seams. The doors, furnished by the Youngstown Steel Door Company, are fitted with Camel roller lift fixtures. The ends are of Dreadnaught corrugated two-piece type with 3/16-in. top and 1/4-in. bottom sections. Copper-bearing steel is used in the ends, doors, roof and the side sheathing. To insure against water leakage, a generous amount of welding is employed throughout.

The floor consists of a course of 2 3/8-in. tongue-and-grooved yellow pine extending crosswise of the car, bolted in place with MacLean-Fogg water-tight bolts and No. 2 speed nuts. On top of the 2 3/8-in. sub-floor is applied a top floor consisting of 7/8-in. kiln-dried spruce lumber running lengthwise of the car and nailed to the sub-floor with cement-coated oval-head barbed car nails. The top spruce floor is applied to assist in the handling of the paper rolls by means of lift trucks and to form a uniformly level floor for the loading.

The side lining is of 1 1/16-in. tongue-and-grooved southern yellow pine. It is blind nailed horizontally to four corner and four intermediate side nailing posts. The end lining is of 1 5/16-in. tongue-and-grooved southern

Principal Proportions of the B. A. R. 40-Ton Box Cars

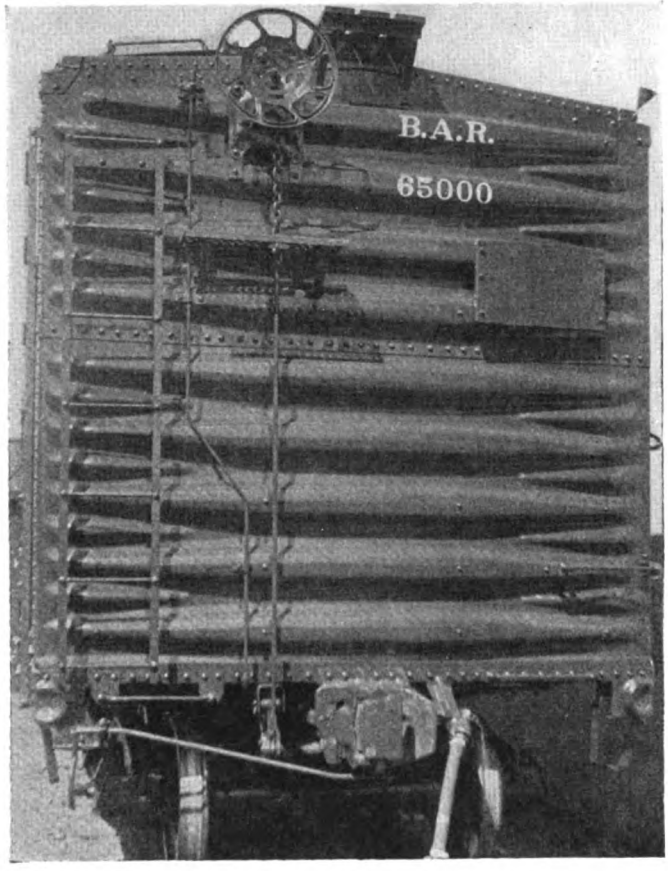
Length inside of body, ft. and in.	40- 5
Width inside of body, ft. and in.	9- 1½
Height from floor to roof at inside width, ft. and in.	9- 2½
Width of side-door opening, ft. and in.	6- 0
Height of side-door opening, ft. and in.	8- 7⅜
Length over striking plates, ft. and in.	41- 8½
Length center to center of trucks, ft. and in.	30- 8½
Width of car over side sills, ft. and in.	9- 9⅝
Width over side plates, ft. and in.	9-10⅜
Cubical capacity, cu. ft.	3,396
Weight capacity, lb.	80,000
Load limit, lb.	90,500
Light weight, lb.	45,500
Ratio of pay load to gross load, per cent	66.5

yellow pine extending vertically and blind nailed to five nailing strips in each end. Blind nailing is used throughout to prevent damage to the paper rolls when coming in contact with exposed nail heads which commonly work out in service.

Steel binding anchors are used in each corner of the car welded to the ends and side posts 53½ in. above the floor level to permit of the use of steel straps which encircle the rolls of paper to secure them in each end of the car thus preventing shifting in transit or yard switching.

The Underframe and Trucks

The center sills of the cars are formed of two 36.21 lb. U. S. S. rolled Z-sections, the top flanges of which



The ends, doors, roof and side sheathing of the B. A. R. cars are of copper-bearing steel

are joined by welding. The side sills are of 6 in. by 3½ in. by 5/16 in. rolled steel angles, extending the full length of the car and reinforced at the bolsters by 6 in., 15.3 lb. ship channels and over the door opening by 6 in., 10.7 bulb angles.

The bolsters are of the built-up type with ¼-in. pressed plate diaphragms and 21-in. by 7/16-in. top and bottom cover plates. Stucki roller-type side bearings are riveted to the truck bolsters. Drop-forged steel body center plates are used.

There are two sets of crossbearers and four sets of crossties used in the underframe. Diagonal braces, pressed from ¼-in. plate, extend from each corner of the car from the junction of side and end sills into the junction of the bolsters and center sills. The end sills are of 6-in. by 3½-in. by 5/16-in. angles, extending crosswise of the car over the center sills. The floor stringers are of 3-in., 6.7-lb. Z-bars extending between the bolsters and crossbearers over the crossties and between the crossbearers at the center of the car; there is one set at each side of the car about midway between the side and center sills, punched to take floor bolts.

The trucks, furnished by the Gould Coupler Corporation, are of the self-alining spring-plankless 40-ton capacity type which embody integral-box double-truss cast steel side frames with Symington hooded-type malleable-iron journal-box lids. Coil-Elliptic springs are used to dampen harmonic oscillation to prevent chafing of the wrappers surrounding the newsprint lading and damage to the ends of the rolls. A. A. R. No. 3 brake beams with Azee brake-hanger wear plates, loop-type forged-steel brake hangers and Creco four-point brake-beam supports, and Schaefer truck levers of forged steel are used. The 5-in. by 9-in. axles were furnished by the Bethlehem Steel Company and the Carnegie-Illinois Steel Corporation, the 33-in., 700-lb., wheels by the Ramapo Foundry and Wheel Works, the brake beams by the Davis Brake Beam Company, the brake shoes by the American Brake Shoe & Foundry Company and the brake shoe keys by the Buffalo Brake Beam Company.

National Malleable & Steel Castings Company Type E single rotary operating couplers with cast-steel yokes and Miner A-22-XB friction-type one-follower draft gear are used. The coupler operating device is of the Imperial type furnished by the Union Metal Products Company. The AB brake equipment was furnished by Westinghouse. All piping is of extra heavy steel and is welded to the body crossbearers. Transco metal brake steps, Brascott side and end ladders, and Universal hand brakes are used.

The doors and ends are painted a dark shade of green, rather than the usual black or red; the sides are red. As cars primarily in newsprint paper service must at all times be clean and free from grease, odors, acids and similar commodities, each car is stencilled to indicate newsprint service, and it is felt that the distinctive painting will help to distinguish the car and prevent its misuse.

Railway Equipment Service Failures

(Continued from page 294)

by tears in the metal. This suggests that special attention should be given to the proper sharpening of drills, a vital factor that is too little appreciated.

It may be advisable to call attention to a rather common application of drilled holes in which difficulties have been experienced. This is the drilling of oil or grease holes in crank shafts. These holes are long and difficult to drill, especially if there is a tendency for the drill to run off. In such instances, when the holes are drilled from both ends they will not line up and I have seen cases where they were 3/16 in. out of line. It is not unusual to find such holes stuffed with waste, in the hope that the inspectors would overlook the defect.

Too frequently in case of fillets, radii and finishes the shop authorities are prone to defend a poor position by saying, "The drawing did not call for it." In return the drafting room may suggest, "It is an important feature of shop practice and therefore not necessary to include it on the drawing."

If it is not advisable to specify these details on every drawing, would it not be possible to establish standard practices as to the radii and fillets, with the understanding that such standard practices are to be followed in all cases? Under such circumstances alibis would not be tolerated and buck passing would be prevented.

Facts Concerning the Buchi System of

Diesel Engine Supercharging*

A discussion of the basic principles of supercharging, how it is accomplished mechanically and the effect on the performance of a Diesel engine

A GREAT deal of misunderstanding exists at the present time, even among the technical men in the Diesel-engine industry, concerning the detailed principles involved in modern supercharging of Diesel engines. This article is intended to clear up some of the basic principles involved in language which can easily be understood.

Basic Principles

Generally, it is believed that supercharging consists merely in forcing more air into the power cylinders at a pressure above atmosphere, and therefore the resulting stresses and increasing pressures are in direct proportion to the increased output. This, however, is far from being correct. As a matter of fact, the primary reason which prompted a study of the possibilities of supercharging is the great loss of volumetric efficiency due to overheating the incoming air both by dilution with the residual gases in the clearance space and also by the heat absorbed from the hot engine parts. This is far more pronounced than is generally suspected even by the most experienced designers.

The effect is self-evident if it is assumed, for example, that the incoming air is heated to a temperature of say, 500 deg. F. Without ramming, the volumetric efficiency would then be only 50 per cent and, therefore, 50 per cent of the engine manufacturing cost is wasted. The above example is made extreme to illustrate the point and for easy mental calculation. Diesel engines generally never reach a volumetric efficiency as low as 50 per cent in the ranges of speed and power usually employed.

From the above, it is easily seen that if this volumetric efficiency is increased to 100 per cent a considerable increase in power can be obtained without the slightest increase in compression pressure, or maximum firing pressure.

At the same time, if the ratio of fuel to air be kept constant, the engine parts will operate considerably cooler because the hot exhaust gases will not be in the cylinder during the suction and compression stroke. Also, the firing and exhaust stroke temperatures will be lower in proportion to the heat removed.

The accomplishment of the above is the primary reason for modern supercharging and accounts for about 30 to 35 per cent of the increased output. Inasmuch as the accomplishment of the above involves a certain amount of machinery, it is only logical to use this equipment for making gains consistent with general reliability of the engine itself. The increased reliability of the engine, due to lower temperatures, permits a further gain of from 15 to 20 per cent making a total overall gain of approximately 50 per cent.

Effect of Supercharging on the Engine Proper

To the average layman, it might appear that the 50 per cent increase in power output would surely result in an increase in engine wear. This, however, is not the case, as a Diesel engine of high compression pressures and inertia of reciprocating and rotating parts, does practically the same amount of friction work at no load as at full load, and even if the output were doubled, the wear on the bearings would not noticeably be increased. The parts which usually wear most, namely, piston rings and cylinder liners, are now better

* From information supplied by the American Locomotive Company.

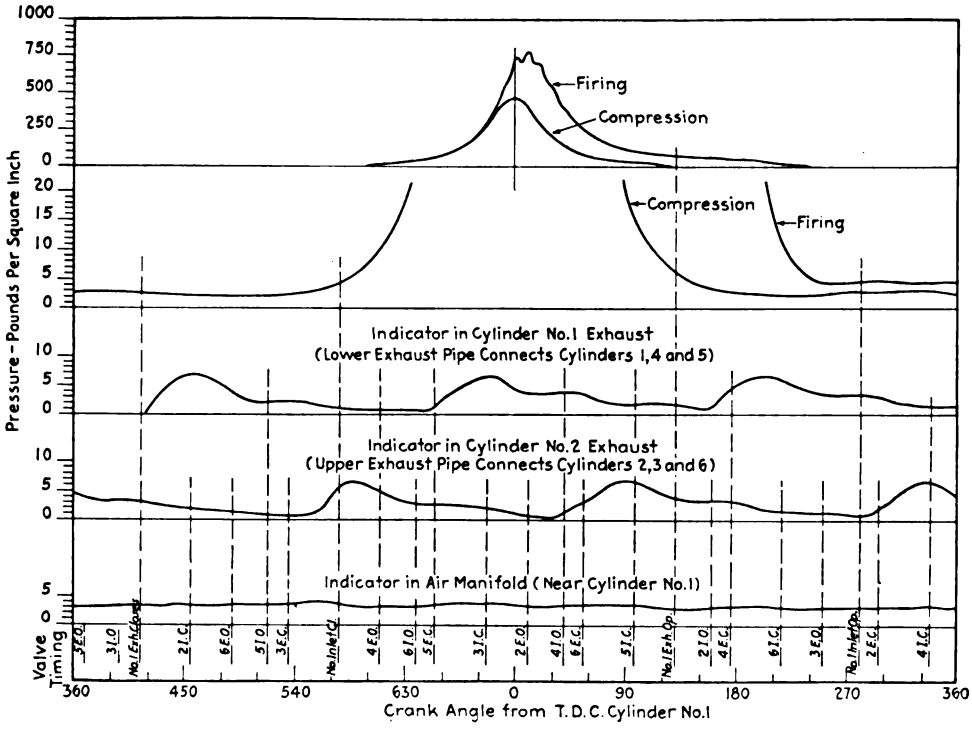


Fig. 1—Group of indicator diagrams showing various operating phases of supercharged 900 hp. engine. The charts, from top to bottom are: (1) maximum compression and firing pressures; (2) enlarged portion of curves to show minimum pressures; (3) and (4) curves, indicator pressures in exhaust manifold through a full cycle range (two engine revolutions) and (5) resultant air pressure in air manifold—this pressure is an average of (3) and (4) combined

cooled thus allowing a better oil film to be maintained so that instead of increased wear, actually less wear may be expected. Also, there would be less tendency of the piston rings to stick.

Methods of Accomplishment

The Buchi supercharging system consists of an exhaust-gas turbine directly connected to a centrifugal compressor. The engine exhaust is piped directly to the exhaust turbine and at full load results in a mean pressure of about two to three pounds per square inch in the exhaust pipes between the engine and the turbine. The energy of expanding this exhaust gas to atmospheric pressure provides the means of driving the blower. The blower creates an air pressure of about three to five pounds per square inch. This air is piped to the engine through an air inlet header.

In order to clean out or scavenge the cylinder of burned gases and cool the engine parts, the inlet and exhaust valves are made to overlap in their opening for a long time at the end of the exhaust stroke, which allows the air to blow from the inlet header through the cylinder into the exhaust header, cleaning out all the exhaust gases from the cylinder and cooling the hot engine parts.

A mean pressure difference of from one to two pounds per square inch exists between the inlet and exhaust pipe. This would not allow a complete scavenging of the cylinder in the small time available. Therefore, in order to assure more effective scavenging, the pressure in the exhaust pipe is made to pulsate so that during the period of scavenging the pressure in the exhaust manifold is very much reduced. This creates a pressure difference between the inlet and exhaust pipe of not one pound but very much more, and results in a violent rush of air through the combustion space from inlet to exhaust manifolds. This pulsation is accomplished by having a multiplicity of exhaust pipes.

A study of the graph in Fig. 1 showing the valve timings, air inlet and exhaust pressures will clearly show the relation of one feature with the other.

In order further to insure complete scavenging of every part of the combustion chamber this must be made so that the air sweeps through the entire chamber in passing from the inlet to the exhaust manifold.

The pressure crank angle indicator diagram in Fig. 2 taken with a Cox sampling-valve-type indicator, also the pressure-volume diagram plotted from the above, shows clearly the increase in area of the card and illustrates how the increase in power is obtained.

The data in Table I shows the difference in performance of the standard and supercharged engine.

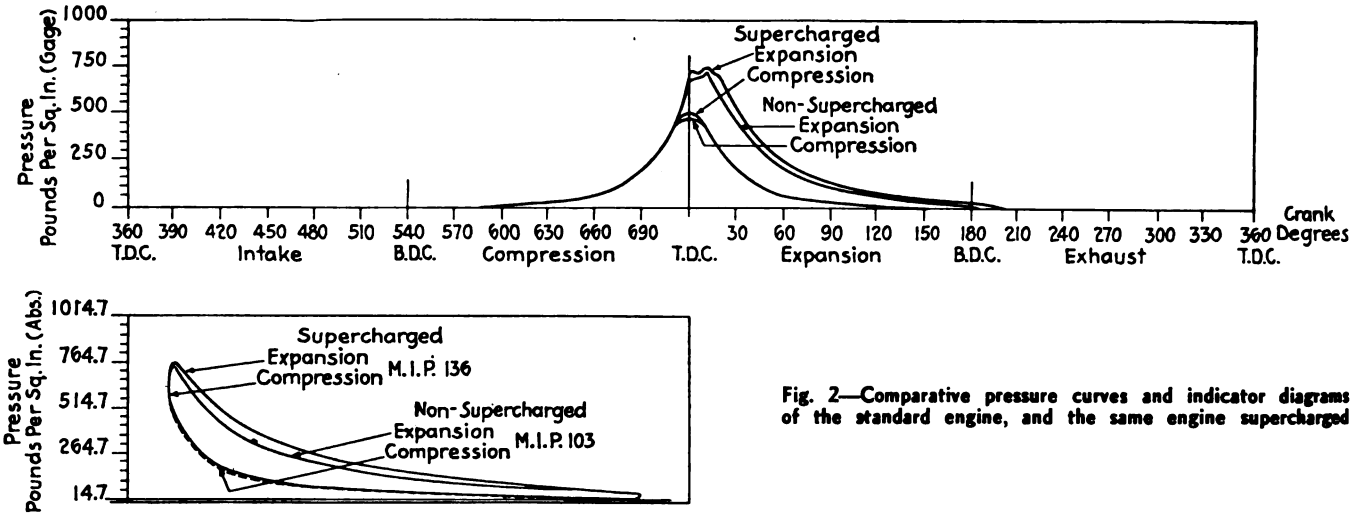


Fig. 2—Comparative pressure curves and indicator diagrams of the standard engine, and the same engine supercharged

Table I—Comparative Performance of Standard and Supercharged Engines

STANDARD ENGINE (WITHOUT SUPERCHARGER)

Type six-cylinder—12½ x 13 in. Fuel pump 16mm. Timing 15 deg., 21mm. rack travel.

Time	R.p.m.	Volts	Amps.	Brake hp.	Temperature Water Inlet	Temperature Water Out	Temperature Oil Inlet	Temperature Oil Outlet	Oil Pressure	Exhaust Temperature	Exhaust Color	Fuel Consumption Lb. per b.hp.-hr.
6:00	700	600	685	604	170	177	168	175	38	840 855 840 840 840 840	Clear	.389
6:30	700	600	685	604	170	177	168	175	38	830 850 830 840 830 840	Clear	.396
7:00	700	600	680	600	168	175	170	178	38	830 850 830 840 830 840	Clear	.397
7:30	700	600	685	604	168	175	168	178	38	825 840 825 835 820 835	Clear	.394

STANDARD ENGINE (WITH ALCO BUCHI SUPERCHARGER)

Type six-cylinder—12½ x 13 in. Fuel pump 20mm. Timing 12 deg., 21mm. rack travel.

Time	R.p.m.	Volts	Amps.	Brake hp.	Temperature Water Inlet	Temperature Water Out	Temperature Oil Inlet	Temperature Oil Outlet	Oil Pressure	Exhaust Temperature	Exhaust Color	Fuel Consumption Lb. per b.hp.-hr.
12:00	700	600	1020	900	158	168	158	164	38	780 730 740 775 740 780	Clear	.368
12:30	700	600	1020	900	160	170	156	168	38	785 735 745 785 745 780	Clear	.371
1:00	700	600	1020	900	160	170	158	170	38	785 735 745 785 745 780	Clear	.371
1:30	700	600	1020	900	160	170	158	170	38	785 735 745 785 745 780	Clear	.371

EDITORIALS

Keep the Mechanical Associations Alive

One of the news pages of this issue carries the announcement that the Committee on Co-ordination of Mechanical Conventions in a recent meeting in Chicago attended by representatives of the Car Department Officers, International Railway General Foremen, International Railway Master Blacksmiths, Master Boiler Makers, and Railway Fuel and Traveling Engineers Associations decided against holding any convention of the associations this year but that, in order to avoid a break in the continuity of the proceedings, open business meetings of the officers and committee members of the several groups would be held on September 27 and 28 at the Hotel Sherman, Chicago.

Announcement was also made that the American Railway Tool Foremen's Association will unite with the General Foremen and it was suggested that efforts be made to revive the activities of the Master Blacksmith's group and affiliate it with the General Foremen.

Under the conditions that the roads have been forced to operate for the past eight years there is not a man in a railroad organization who has not heard talk about cutting expenses until many have reached a frame of mind where the saving of a dollar for labor and materials is considered of vastly more importance than the proper and intelligent operation of a business the job of which is to furnish efficient transportation under any conditions. It requires a great deal more hard thinking to run a business under conditions such as exist at the present time than it does when there is plenty of business and the supply of funds and men is sufficient to do a good job. The only object in mentioning this at all is to bring out the reason why these mechanical associations are of such inestimable value to the railroad industry and why every effort should be made to encourage their work, not only for the influence they have in making it possible for their members to function more efficiently on their respective jobs but in helping to hold up the morale of the supervisory organizations at a time when morale is not especially high.

After a lapse of several years four of these groups held conventions in Chicago last Fall which were an outstanding success in every way and many enthusiastic comments have since been heard concerning the meetings and the value of the reports and discussion of the variety of subjects that were considered. The impetus of last year's convention revived interest in the work of these groups with the result that some of them will, without doubt, have unusually complete committee reports to present at this year's meetings that will place on record the progress that has been made during the intervening twelve months.

The announcement concerning the possible affiliation of the General Foremen, Tool Foremen and the Master Blacksmiths gives rise to speculations as to what the future of these groups may be. All three of them, before 1930, were extremely active associations with a widely distributed membership and exerted an important influence in their respective fields. It is therefore a question in the minds of many as to why these three groups apparently have lost ground and are now in the position of having to build almost from the ground up. Possibly the answer may be that the conditions in the field have changed greatly; possibly it is because the older group of leaders of these three associations, who were the driving force that caused them to remain active, have laid down the reins of leadership expecting younger men to take up where they left off; possibly it is because the present officers of these associations have not faced certain facts as they are and rebuilt accordingly. It is rather difficult to believe that once-powerful associations such as these have lost their vitality simply because supervisors in the industry have become indifferent to their value. In the discussion of this situation with individuals it has been inferred that possibly some of the difficulty may be because these minor groups do not have the hearty support of the higher officers. This last possibility may be discounted for the higher officers have supported the associations that have continued to do a constructive job of planning programs which are of obvious value to their members and so to the railroads.

The minor mechanical associations came into being because of a very definite need for a place where groups of supervisors might consider the many individual ideas for improving methods for the operation and maintenance of mechanical equipment. The problems of design and standards have always belonged to the Mechanical Division. It has never been the function of these minor associations to undertake the formulation of policies for the industry, the development of working agreements between roads or to establish standards for the design of equipment or for materials. It has, however, been their function to bring together in one place the experience of the operating and maintenance forces relating to methods and supervising problems of the repair of equipment and the use of materials. In this manner the work of these groups has undoubtedly been of considerable value to the Mechanical Division.

When it is considered that expenditures for maintenance of equipment constitute a major part of railway

operating expenses and that locomotive repairs alone is the largest single expense account it seems strange that the day-by-day problems of the men responsible for the administration and supervision of this important part of railway work are not the concern of an influential association. Why is this not the logical field of endeavor for a new organization of broad scope which could easily be built out of the combination of the General Foremen, Tool Foremen and Blacksmiths? A single indication of what can be done in other industries is the rapid rise to a place of importance of the American Society for Tool Engineers, which has been built with an understanding of the important place modern tooling equipment has in industry.

The General Foremen's association has suffered a loss of membership by the transfer of interest on the part of the general car foremen to the Car Department Officer's Association and rightly so for that is where they belong—in an organization devoted expressly to the peculiar problems of car maintenance, inspection and interchange. This is one of the facts that must be faced, one that has been brought about by changed conditions. The real field of the General Foremen's association of the future is strictly locomotive maintenance and the group should be built with the idea of arranging programs of such broad interest that master mechanics, shop superintendents, both shop and enginehouse general foremen, certain department foremen, shop engineers and supervisors of shop machinery and tools will be attracted to its membership.

Obviously, as far as the work of tool foremen and the blacksmiths is concerned it probably will be worth while to build the organization in such a manner that their separate identities, as sections, may be maintained for it would not serve the objectives of association work to submerge these groups too deeply in the background of the broad problems of locomotive maintenance.

There is no question of the need for such an association. There is no question of the value of it to the supervisors in the mechanical department. The only question seems to be that of discovering a small group of leaders of sufficient vision to realize the opportunities, of sufficient courage to do the job that must be done under the present conditions and who have the ability to formulate plans of obvious benefit to their members and to the railroads. This having been done, the support for such an organization will be forthcoming.

Apprentice Training Methods

With a very few exceptions, apprentice training was badly neglected on the railroads of this country during the long, drawn-out depression. When business improved the railroads, recognizing this weakness, started to recruit apprentices and made efforts to improve their training methods. The "recession" slowed down or stopped these efforts in many instances, but fortunately, not in all of them. This is clearly reflected in the extracts from some of the letters from apprentices which have appeared on our Gleanings Page in recent months. These experiences naturally were paralleled more or less closely in the heavy or durable goods industries.

If we can find our way out of the economic haze, in which we have been groping for so long a time, and get back on a sound basis, a plentiful supply of well-trained craftsmen will be needed to catch up on deferred maintenance and to meet the demands for newer and higher types of services.

From the standpoint of the nation as a whole, greater skill on the part of the employees and new and improved facilities and equipment will be required to meet the competition for world trade from cheap labor in other countries. The railroads are the backbone of our transportation system, which is vital to the success of our commerce and industries, and they must do their full share by improving their effectiveness, not only for the general welfare, but also to protect their own interests in competing with other types of carriers.

In the early part of the present century, the railroads pioneered in the introduction of modern apprenticeship training methods. Some of them are giving an excellent account of themselves in this respect today, and yet, by and large, the most aggressive and advanced thinking in apprenticeship training is to be found in the industrial field. Railroad mechanical department officers, therefore, will do well to look into the best practices in that field for recruiting and training of apprentices and workers.

The Effect of Coal Fines On Fuel Consumption

It has been estimated that railroad coal costs in 1938 will increase by approximately $19,000,000 over the cost in 1937 as a result of new wage agreements and the National Bituminous Coal Act. Although the increased cost of railway fuel is largely out of control of railroad men, much can be, and has been, done to reduce the total amount of the fuel bill by designing locomotives and their firing equipment to produce higher boiler efficiencies, by keeping motive power in the best operating condition and by avoiding inefficient firing practices. The effective fuel conservation efforts of railroad mechanical-department officers working on their individual roads and through an aggressive specialized group like the Railway Fuel and Traveling Engineers Association were never more needed nor potentially productive in saving railroad fuel money than today.

In connection with this subject there is the addi-

tional item of fuel loss resulting from the use of coal containing high percentages of fines. Tests conducted about 15 years ago at Purdue University revealed that mine-run coal as received was such that 12.5, 19.94 and 31.3 per cent passed through ¼-in., ½-in. and 1-in. screens, respectively, and that the stack loss from this coal ran from 3 to 9 per cent. Coal purchased as 1¼-in. screenings was such that 37.59, 57.62 and 95.56 per cent passed through ¼-in., ½-in. and 1-in. screens, respectively, and that the stack loss from this coal ran from 12.5 to 17.8 per cent. With high stack losses increasing with the higher percentages of fines in the coal, much of which loss is either unburned fines or fines from which the volatile matter alone is burned, some thought should be given continuously to the grade of coal used as locomotive fuel.

At least one railroad in the east has undertaken a study of this problem. Besides trying to establish the fuel consumption on locomotive runs with coal as received from the mines, this railroad has also undertaken to determine what increase in fines result from handling the coal in the loading stations at its terminals, such increase resulting when coal drops from heights as much as 45 ft. against deflectors at the loading stations and into the locomotive tenders.

If the proper handling of coal at loading stations will reduce the percentages of fines therein and thereby effect a well defined decrease in fuel consumption, the study of such practice should be extended.

Freight Cars And Safety

Speeding up the operation of freight trains makes it necessary to take greater precautions to insure safe and reliable operation. Undoubtedly, freight cars of the older and obsolete designs would have been discarded long before this had conditions been more favorable in recent years. Fortunately, also, a steady improvement has been made in accident prevention, and yet it cannot be gainsaid much still remains to be done.

The suggestion has been advanced that mechanical department officers might well take a firmer stand in matters relating to the operation of obsolete freight cars or cars with poorly designed or defective parts. If a piece of track or a bridge is weak or defective, the engineering department clearly specifies the conditions under which it can be used, and the operating department sees that these conditions are observed. Ought not the mechanical department to take an equally firm position in the operation of the equipment in its charge?

The use of the arch bar truck in interchange service has again been extended to January 1, 1939, although past records show numerous accidents chargeable to such trucks. Director Patterson, of the Bureau of Safety, of the Interstate Commerce Commission, has consistently pounded on the need for periodic inspection of couplers and draft gear, and also that steps be taken to insure that the height of the coupler above the rail be maintained within specific limits under all conditions. Here certainly are problems demanding the best thought and action on the part of the mechanical department, and so much is involved it would seem the mechanical department officers could well afford to take a decided and firm stand to improve conditions.

Metal Spraying Possibilities

Metal spraying, the art of building up worn parts and the surfacing of others with corrosion resistants by metal sprayed from an air-turbine gun after being heated to a molten condition by an oxyacetylene flame, has not been used extensively in the railway field, in spite of the fact it has long been considered by the maintenance departments of other industries as an indispensable process. However, several railroads have made a study of the process and are now using it for building up piston rods, reverse-gear parts, stoker parts, air-pump piston rods, feedwater piston rods, and injector parts. These, as well as many others, have been successfully built up to size, and it has been found that they wear much slower after installation than the original parts; for example, a metal-sprayed and a new pump plunger were tested recently and it was found, after each had run the same length of time, that the metal-sprayed plunger had worn 30 per cent less than the new one.

One eastern railroad, which has been using metal-spray equipment since 1931, reports an annual return on its investment of approximately 350 per cent. It has been used in reclaiming parts of locomotive accessories and air-conditioning equipment, as well as the surfacing with corrosion resistants of equipment parts subjected to atmospheric and chemical corrosion.

With the continued advance in the use of internal-combustion engines for railroad motive power, the maintenance departments of the railroads might well investigate the advantages of metal spraying as used in other fields for tinning bearings to receive babbitt, and building up cylinders, pistons, crank shafts, bearing fits, valve and cam-gear parts, as well as other parts subject to wear and frequent replacement.

It is a rarity to see metal-spraying equipment in railroad shops and few mechanical officers seem to have any knowledge of the subject. On the other hand practically every major oil company owns and operates metal-spraying equipment. Many railroads are overlooking a device which could aid materially in cutting maintenance costs and improving the service of a very considerable list of specific parts of motive power and rolling stock.

Gleanings *from the* Editor's Mail

(The Apprentices Speak)

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Blueprint Reading and Seniority

What we need to improve our apprenticeship is better and more schooling on blueprint reading. We receive two hours a week schooling on blueprint reading, arithmetic and trade theory, but that is not enough. They tell us to study at home, but what can you learn by yourself, if you have no one to explain the hard work to you? We should also receive more seniority. We get two years' seniority after putting in our apprenticeship for five or six years.

We Are Delighted

I am fortunate in working in a shop that, generally speaking, looks after its apprentices well. We have a good instructor and a superintendent who is doing all he can for us. I was informed that our shop superintendent has been following the apprentice articles (Gleanings Page) and has advised all shop foremen to be sure to keep apprentices strictly on schedule. This is just one case where your efforts for better apprenticeship programs have been recognized and have accomplished good results.

Frank Confession from a Special

When the railroad employed us, it started us at a good salary, and we were a loss to them for quite a while until we began to become acquainted with the various complexities of railroading. Therefore there has been quite an investment made in us, and in most organizations it would have been seen to that this investment was utilized to its best advantage. Does it seem strange that we wonder why there is no system adopted under which we would gain a fairly good vision of the scope of railroading, and not spend our three years in what seems to be a haphazard manner, our experience depending solely on the management under which we are placed, with an occasional release for test work? In this way some of us are quite fortunate, while some pass their time as a little better than a laborer, or in some cases, a super-office boy.

Capable Young Men Needed

Many young men with whom I have talked regard the present apprentice system, hopelessly, as a method of exploiting cheap labor. While I do not feel that this attitude is completely justified, there are many evidences that might lead one to draw such a conclusion. There is a distinct need for effective apprentice training today more than ever before, and I am considering the case from the viewpoint of the railways, as well as from that of the young men. Many of the reasons seem obvious to you and to me, but perhaps they need restating for the benefit of others. The average age of railway personnel is higher than in other fields—a fact not serious in itself, but indicating that young men are not being attracted to the railways to replace natural retirement. New equipment, methods and materials, higher train speeds, etc., create more exacting requirements in the mechanical and maintenance departments, and require specially trained men. Finally, there is a great need for a sympathetic group of employees to assist in combating the trend toward government ownership.

Conditions Ideal — Almost

I am happy to report that conditions at our shop are ideal, almost. That is, we have a full time instructor, full co-operation of our supervisors, technical data through an I. C. S. course, mechanical drawing, and a class room that isn't big enough or fit for storage. We secure the least co-operation from the "old timers," who received their training via the helper route. Their first salutation is "Howdy, mate, make yourself at home, anything you want to know, just ask me." We do ask. Maybe they can't answer all our questions, so they tell us after a few questions, "Ask that———good for nothing, lazy, etc., instructor, that's what he gets paid for; I'm too busy to answer questions all day." They let us act as "tool getters and taker backers" and all-around Western Union boys. Sometimes they will let us clean the dirt and grease off a job and lots of times let us swing the sledge. We are willing to work, realizing that experience is the best teacher; but we want to do *the work*. We find an ideal attitude among those who served an apprenticeship. They explain the work and give us plenty of information that isn't in the book. They let us do the work, correcting us and giving us helpful hints.

Apprentice Classes on Company Time

Apprentices on the Canadian National attend class two hours each week, the total number of hours being limited to five hundred during an apprenticeship. Two or three classes are held each day and the number allotted to each class is from 10 to 15 apprentices. The classes are kept down to the smallest possible number to avoid taking too many apprentices from the shop at one time. The class time is apportioned to the study of mathematics, drawing and trade theory. In the study of mathematics an apprentice is required to make a review and is then given a test examination, in order to find out in what part of the book he should start to study. This is done to prevent time being spent on a subject with which the apprentice is familiar. In drawing, most of the first year is spent on geometrical drawing and projection, then on simple mechanical drawing, the apprentices making their drawings from objects. The importance of sketching is stressed; all apprentices may not make draftsmen, but they are all taught to make an intelligent working sketch. In trade theory the apprentice studies a textbook that applies to the work that he is doing in the shop, i.e., when on lathe work in the shop, the textbook studied in class is on lathe work. By this method the apprentice gets the theory of the work, which helps him in the practical shop work. Quite a number of the draftsmen working for the company are ex-apprentices who received their first training in drawing in the apprentice classroom. The railway does not believe it is a good policy to pay an apprentice for all the time that he must spend in study. The company pays for the two hours spent in class each week, but the apprentice must spend at least two additional hours a week in home study. It is gratifying to the railway to see the interest taken in class study and the majority of apprentices spend much more than two hours a week on study in their own time.

IN THE BACK SHOP AND ENGINEHOUSE

Safety Railings for Running Boards

The illustration shows safety railings applied to the outer edge of running boards of Bessemer & Lake Erie locomotives for the protection of mechanics when it is necessary for them to use the running boards while making locomotive repairs in shops and enginehouses. These railings, except the sockets which hold the vertical posts in place, are removable and are taken down before the locomotive leaves the shop or enginehouse.



Safety railings applied to running boards of B. & L. E. locomotives undergoing repairs

This device consists of, first, a series of permanent sockets spaced about 5 ft. apart along the outside edge of the running board; second, a number of vertical removable posts which are held in place by inserting the bottom of each post into the socket; and, third, several lengths of ¼-in. chain, each length being about 5 ft. 6 in. overall length and extending horizontally from a slot in the top of one post to a similar slot in the top of the next post, there being a single chain between each two adjacent posts. The illustration shows this railing as applied in six sections to the entire length of a running board. However, one or more sections may be used at one time, depending upon the nature of the work to be performed.

Each post socket is a 3-in. length of 1¼-in. pipe, with a steel disk, ¼ in. thick, welded within the pipe flush with the lower end; this disk has a ½-in. hole for drainage. The bottom of the post rests on the top of this disk. These sockets are welded to the outer face of the angle or tee at the outer edge of the running board, with the top of the socket flush with the top of this angle or tee.

Each post is a 3-ft. length of 1-in. pipe, flattened at the top for a distance of 3 in., the post being so inserted in the socket, or so rotated after insertion, that this flattened portion extends crosswise of the locomotive. In the middle of this flattened portion is a vertical slot, open at the top of the post and extending 2½ in. downwards, into which the ends of the two adjacent lengths of chain are placed. The ends of the chains extend slightly past the slot in the post.

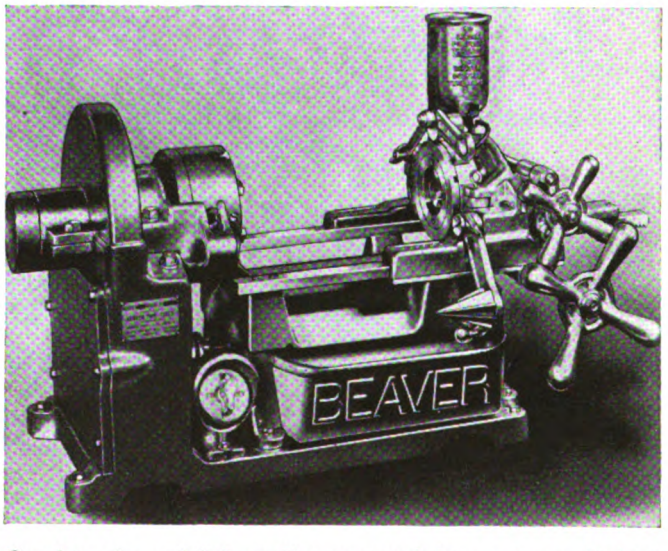
At the top of the flattened portion of the post, above the chain links in the slot, are two 7/32-in. holes in line horizontally, one on each side of the slot. At each of these holes a 3/16-in. bolt and nut is applied to hold a flat keeper bar which prevents the chains from being accidentally pushed upward out of the slot.

To remove the railing, one keeper bolt is removed from the top of each post and the other bolt loosened, after which the keeper is rotated around the loosened bolt until it ceases to interfere with lifting the chain out of the slot at the top of the post. The chains are then lifted out of the slots, and the posts are lifted out of the socket.

Power Drive Converted To Pipe Machine

The Beaver Pipe Tools, Inc., Warren, Ohio, recently announced that users of pipe and bolt cutting machines can purchase the illustrated Beaver Model-B pipe and bolt machine complete as shown, or in units starting with the simple Model-B power drive. The power drive is used to operate all makes of hand pipe threaders, cutters, and reamers for fabricating pipe from ⅛ in. to 2 in. diameter. It can also be used with a drive shaft to operate gear tools to cut and thread pipe sizes from 2½ in. up to 12 in.

The Model-B power drive can be converted into a complete ⅛-in. to 2-in. portable pipe and bolt cutting and threading machine as follows: The cap from the gear case is first removed and the spindle is reversed so that the chuck is directly over the motor. The cap is then replaced and an automatic chuck wrench ejector added. Next the outboard pipe support and sliding pipe rest used with hand tools are removed. The hood is then placed over the motor and bolted in position after which the carriage, reamer, and chip trays are placed in position. Finally a wheel or knife cutoff unit, whichever the user specifies, is added and a quick-opening adjustable die head is mounted on the chuck. Finally an oil reservoir is added. When these operations are completed the Model-B machine will be ready for use. Shop time for making these alterations is estimated as 12 min.



Complete pipe and bolt machine converted from a Beaver Model-B power drive



EXTRAVAGANT ECONOMY

***by* Walt Wyre**

WHEN Jim Evans told the superintendent of motive power that one reason for excessive use of material in the Plainville roundhouse was because the stores department didn't keep enough material on hand, the S. M. P. thought the roundhouse foreman had a couple of nuts loose.

"If they don't buy material," the superintendent of motive power snorted, "how can you use it? I suppose the reason for using over 30,000 pounds of brass last month was because there wasn't any bought! Piston packing, driver tires, valve bushings—look at this!" The official slapped the desk with his fist so hard that the sheet of paper with the figures on it danced. "No wonder the S. P. & W. is not making any money!"

Evans, accustomed to the outbursts of the superintendent of motive power, waited patiently for him to calm down before attempting to explain. The foreman bit off a hunk of "horseshoe" and moved his chair around so the cuspidor would be convenient.

"And look at our labor costs!" The S. M. P. pointed accusingly at figures on another sheet of paper. "Don't tell me all that money was spent because you didn't have material!"

"Part of it was," Evans replied in a matter-of-fact tone.

If the S. M. P. had a pressure gauge on his think tank, the needle would have bent the peg on the high side. He roared like a passenger train going uphill through a deep cut.

"There's no excuse for the cost of turning power being



Out came the little black book. "I'm beginning to see why we are using an excessive amount of material and labor costs are running up", the superintendent of motive power commented

so high at this point, and I'm going to stick around here awhile and find out why!" he snapped.

"Well, if you'll excuse me a minute I'll go see how they're coming with the engine for 82. It's called for 10:15 and not out of the house yet," Evans said, rising.

The official grunted something that Evans took for acquiescence and he headed for the roundhouse.

The foreman found the hostler sitting in the cab of the 5086 that was to be used on the fast freight. "What you waiting on?" Evans asked.

"Waiting on machinists to finish," the hostler replied.

Machinist Cox was standing by the locomotive leaning on a side rod. The nut and collar were missing from the crank pin.

"How much do you lack?" Evans asked.

"Just the side rod collar and nut," Cox replied. "Threads were stripped on the old one."

"Where's your helper?"

"He's in the machine shop waiting to get a nut bored out and threaded to fit. There wasn't any in the storeroom," the nut-splitter explained.

The 5086 got out without any delay, but it wouldn't have if the engine crew hadn't got on her in the roundhouse and fortunately the locomotive had almost a full tank of water and didn't need any oil.

After lunch the superintendent of motive power was in a better humor. He had gotten rid of his excess steam before noon.

About one-thirty John Harris, the roundhouse clerk came to the machine shop looking for Evans. "The 5091 broke a driver tire," the clerk told the foreman.

"Where did it happen?" Evans asked.

"Just this side of Walker's switch," Harris replied. "The dispatcher wants to know how soon you can send an engine out to bring the train in," he added.

"Tell him the 5088 and right away. She came in on 82 and is still hot. Wonder if the 5091 can make it in?" Evans pushed his hat back and rubbed his head thoughtfully.

"Don't know," the clerk said as he started back to the office.

"What are you going to do?" the S. M. P. inquired.

"It's only about seven miles out," Evans said. "I've got my car here. Believe I'll drive out and see what the engine looks like. Want to go?"

The official did. Ten minutes later with a machinist and helper they were on their way.

Fortunately, aside from the broken tire, no great amount of damage was done and the 5091 was able to come on in light at slow speed. It reached Plainville a little after three o'clock. Evans had been back at the roundhouse nearly an hour.

"Why the tires are almost new," the superintendent of motive power commented when he looked at the engine. "Have you got one on hand?"

"Afraid not," Evans said. "I'll ask the storekeeper."

"No, haven't got any tires for a 5000." The storekeeper picked up a clip board and began to thumb through a bunch of requisitions. "I've got some ordered but they haven't been shipped yet. I'll rush them."

"How long do you think it'll take to get them?" Evans asked like a person expecting bad news.

"Oh, ten days or two weeks," the storekeeper said.

"Can't you get them sooner than that?" the S. M. P. asked with a trace of irritation.

"Afraid not, but I'll do my best."

Evans swore mildly as he rose to leave.

"Now what are you going to do?" the official asked Evans as the two left the storeroom.

"Got to do a little figuring," the foreman told him. "Don't see how I can do without the 5091 two weeks. She's just off the drop-pit in good condition and I sure need good engines bad." Evans spoke more to himself than to the S. M. P.

NEXT day the inspector reported that the 5076 would be due for a five-year test in two more days. One more trip and she would have to be tied up. On top of that the morning lineup showed two C. C. C. specials for that night. By the next morning serviceable engines would be plenty scarce in Plainville.

"Well, I guess that's that!" Evans remarked as he laid the lineup on the desk.

"What's the matter now?" the superintendent of motive power asked.

"Just another case of the high cost of turning engines going higher," Evans replied without intending to be sarcastic.

"What are you going to do?" the official asked.

"Got to get a tire on the 5091 and have her ready to run by to-morrow afternoon. " Evans reached for the lineup and handed it to the official.

"Where you going to get a tire?"

"I've got to get one somewhere," Evans said seriously as he started to leave the office.

The foreman went to the tool room and got a tire caliper and from there to the cement platform near the storeroom where tires were stacked. After measuring every tire that looked as though it would do, the fore-

man found one that could be used. It was worn almost to the limit. He marked the tire with a piece of yellow keel and headed back for the roundhouse. He met the superintendent of motive power near the drop pit.

"Did you find one?" the official wanted to know.

"Yeah, I found one that can be used, but I'll have to turn all the other tires on the 5091 to match.

"That'll take a lot of miles off them."

"Yes," Evans agreed, "but I don't see any other way out of it. Do you?"

"Afraid not," the S. M. P. said as he made notes in his little black book.

By four o'clock the next afternoon the wheels had been dropped, nearly an inch cut taken off each tire except the new second-hand one, and the wheels were back in place. Machinists were putting the rods up when Evans took a call on the engine. It was the only one available for an extra west that the dispatcher was worrying about.

THE foreman was in the roundhouse office alternately chewing his finger nails and a pencil as he attempted to answer some of his correspondence when the engineer that brought the west bound extra in came to the office. "Say, that 5090 I just came in on will have to have new piston packing."

"Which side?"

"Both sides. They're blowing like a politician a week before election. I had to double Clear Creek hill and if the booster hadn't been working I wouldn't have got over then. Gimme a work report," the engineer added.

A night machinist pulled the pistons from the 5090. Evans looked at them just before eight o'clock next morning. No argument about it, new rings were required to put the engine in condition to run. When the eight o'clock whistle blew, the foreman gave machinist Clark the work slips on the engine and a requisition for two sets of rings.

Fifteen minutes later Clark found the foreman. "There are only two rings in the storeroom of the right size," the machinist said.

Evans pondered a minute. then said, "Well, put them in the side that looks the worst and put the pistons in, rings or no rings. We've got to run her."

"Both sides are the worst," the machinist said. "What I mean is the packing is completely down."

Evans pondered again. "I'll take a look."

The machinist was right. The rings on both pistons were two trips overdue at the scrap dock. The foreman looked at first one then the other. Suddenly he raised up and said, "Take all of the rings off without breaking them if you can, and whatever you do, don't break over two of them."

"Might as well be broke," the machinist muttered as Evans walked away, but the nut-splitter proceeded to follow instructions. By working carefully he removed all of the rings without breaking any of them.

In the meantime the foreman went to the storeroom and started to look around.

"What are you hunting?" the storekeeper inquired.

"Afraid you haven't got it," Evans replied, half joking, half serious. Then he stopped by the rack where rolls of metal used for shimming locomotive tires were stored. He pulled out about a foot from a roll of one-sixteenth of an inch shim stock. "This stuff has got quite a bit of spring to it," Evans remarked.

"Yeah, it's pretty good metal," the storekeeper agreed. "Could I sell you some of it?"

"Let's see your tin snips," Evans replied.

"Want to take a sample with you?" the storekeeper asked as he went to get the tin snips.

The metal was hard cutting with a pair of tin snips, but Evans managed to cut off a piece about ten inches long. He then cut a strip of the metal approximately three-eighths of an inch wide lengthwise of the piece. He went back to the roundhouse carrying the narrow strip of metal, bending it back and forth as he walked.

The storekeeper stood and watched, wondering who was nuts, he or the foreman.

The machinist was cleaning the ring grooves on the right piston when Evans came up. "How did you make out?" Evans asked.

"O. K.," Clark replied. "I got all of the rings out without breaking them."

"That's good because you may break one or more putting them back in." The machinist gave Evans a hope-you-are-harmless look; the foreman continued, "Here's what I want you to do. Go to the storeroom and get a strip of one-sixteenth shim stock about half again as long as the distance around the piston. Understand?"

"Be about ten feet long?" The machinist laid a folding rule across the diameter of the piston.

"Yeah; then I want you to cut two strips of the shim stock just wide enough to fit loosely in the ring grooves."

"But why one and a half times as long as the distance around the piston?" the nut-splitter wanted to know.

"May not need to be that long, but I'll show you when you get the strips."

While the machinist was getting the shim stock and taking it to the power shear to cut the strips, Evans went to the roundhouse office to see how things were coming along there. He had been so busy figuring how to get engines out that he had entirely forgotten that the superintendent of motive power was on the job.

That official was in the office looking over work reports, checking overtime and prying into things in general when Evans entered.

"Say, it looks like there's been a lot of unnecessary overtime," the S. M. P. said.

"Yes, and I'm afraid there's going to be some more, but I don't see any way around it." Evans explained about the piston rings and added, "That's just an example."

While the two were talking, the engine inspector came in to give a work report to the clerk to copy.

"What you got?" Evans asked.

"It's the 5087," the inspector replied, "and there's quite a bit of work on her. All of the rod bushings are worn, some of them past the limit," he added.

"Yeah," Evans sighed, "we've renewed most of them every trip for the past month."

"Why don't they last longer?" the superintendent of motive power asked.

"Well," Evans replied, "there are several reasons. The pins are out of round and driving boxes pounding. I'm going to run her over the drop-pit soon as the storeroom gets in some crown brasses for her. I'll have the pins trued up at the same time."

The official made some notes in his little black book and went out to look at the locomotive.

It took the machinist and his helper over two hours to cut the strips and fit them in the grooves. The power shears were a little out of line and the mechanic couldn't make them cut straight. After getting the first strip he cut too narrow near the middle, he cut the next two a little wide and finished them to size by draw filing.

The superintendent of motive power, after looking over the 5087, walked out to the shop to look around a bit. He found the machinist filing the strips and wanted to know what they were for.

"I guess they are to shim up the old rings on the

5090. There wasn't but two new rings to fit her in the storeroom," Clark explained.

The official watched a few moments then walked away. He met Evans coming back to the shop and went with him.

"Strips are finished," Clark told the foreman. "Now what do I do with them?"

"Here, bring them over to the work bench," the foreman replied. "Get a ball pein hammer."

Evans opened the jaws of a vise about three inches, then laid one of the strips across the opening. He struck the shim stock with a hammer, bending it into the shape of a wide shallow V. Then he moved it three inches, turned the strip over and formed another V in the opposite direction.

"I see," the machinist said. "You want to make the strip corrugated so it'll have some spring to it and give them old rings some snap."

"That's what I hope," the foreman replied. "Put an old ring with a spring under it and a new ring on each piston."

"Looks like it might work," the superintendent of motive power said as they walked away.

"SAY, Mr. Evans, the 5073 needs new valve bushings on the left side again," a machinist came up and said.

"What does he mean—again?" the S. M. P. asked.

"Has only been a few trips since the bushings were renewed," Evans explained. "The bull rings are worn so badly that bushings don't last long. You see—"

"Let me finish," the official cut in. "There aren't any bull rings in the storeroom, and you are using more bushings because you haven't any bull rings."

"That's right."

"Let's go to the storeroom . . . What's the trouble we can't get material when we need it?" the superintendent of motive power asked the storekeeper.

"I order everything the foreman asks for," the storekeeper replied. "But sometimes it takes quite awhile to get it and sometimes we don't get it at all. You see, the railroad hasn't got the money to buy everything they need."

"But we've got to keep the engines running and we can't do it without material," the S. M. P. argues.

"That's right," the storekeeper agreed, "but—"

"Got a middle connection brass for a 2700?" a machinist helper asked from the counter.

"No," the material clerk replied.

"You can use a 5000," the storekeeper said. "It's just a half inch bigger outside and an inch and a half longer."

"How much more will it weigh?" the official asked.

"Oh, about five pounds."

"Uh-huh, five pounds more brass in the scrap and extra time for a machinist cutting it off on the lathe."

The material clerk laid the brass casting on the counter. "Is that all?"

"No," the helper said, "I want six one-inch bolts eight inches long."

"Nuts?" the clerk said, meaning did he want nuts for the bolts.

"Yeah, eight hex."

The clerk returned. "Have to give you one by tens. Haven't got the eights."

Out came the little black book. "I'm beginning to see why we are using an excessive amount of material and labor costs are running up," the superintendent of motive power commented.

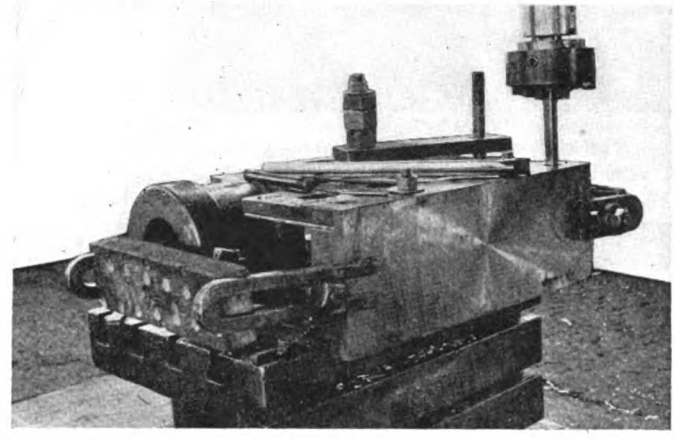
"Yeah, we sure are using lots of it, especially brass and valve bushings," the storekeeper said. "If we got everything we ordered I don't know how much we would use."

"Well, if Evans uses as good judgment ordering as I think he does, my opinion is we'd use a whole lot less," the superintendent of motive power said. "It seems to me like a case of extravagant economy."

Evans nodded and reached for his plug of "horseshoe."

Reaming Crosshead Bolt Holes with a Drill Press

To avoid the breaking of reamers while reaming tapered holes for crosshead bolts at the Pen Argyl shops of the Lehigh & New England a foreman designed the illustrated universal chuck which is threaded to a socket for application to a drill press. The universal chuck is tightened sufficiently to revolve the reamer but loose enough to permit slipping of the reamer should it become fast in the bolt hole. When the reamer slips it is removed from the hole, cleaned and oiled, reinserted and the reaming continued. Since the application of the universal chuck for this purpose the breakage of reamers has been entirely eliminated.

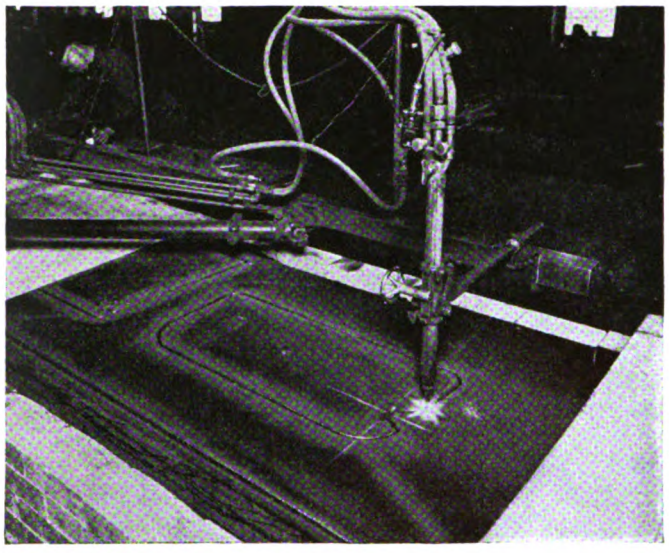


Application of a universal chuck to the spindle of a drill press for reaming crosshead bolt holes

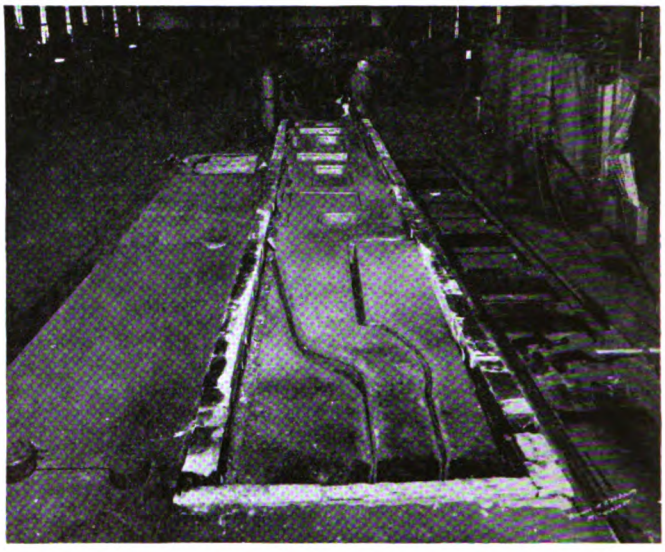
Cutting Locomotive Frames In the Back Shop

Four side-frame sections for a mallet locomotive were recently machine gas cut from SAE 2035 rolled steel slabs in the Milwaukee, Wis., shops of the Chicago Milwaukee, St. Paul & Pacific. Each of the slabs was 23 ft. long, 34½ in. wide, 5 in. thick, and weighed 14,800 lb.

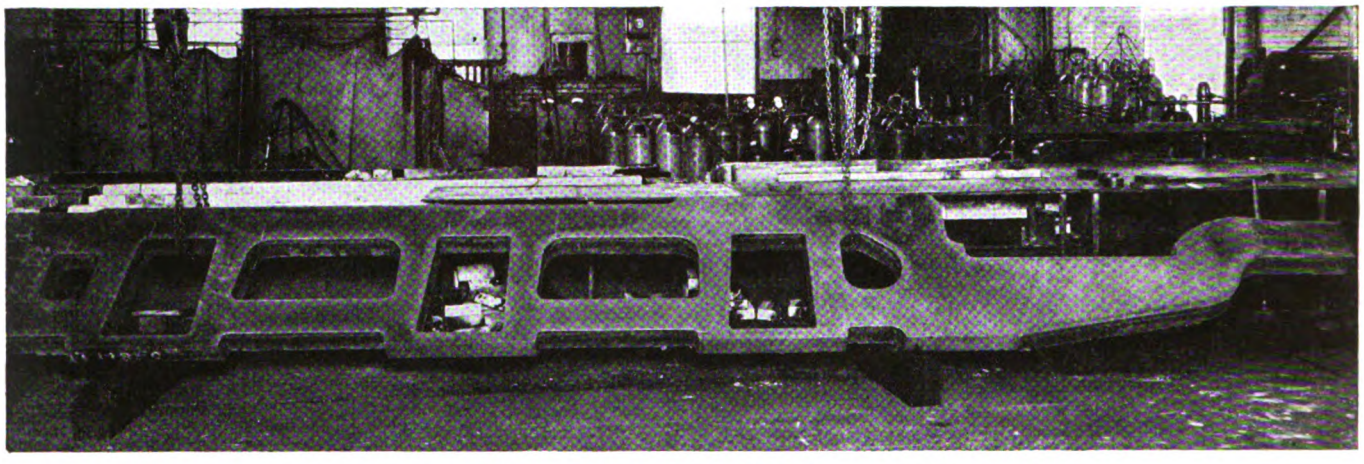
This shop is equipped with an Airco-DB No. 1 Travograph, which has a range of a maximum rectangle 4½ ft. wide by 11 ft. long. In order to cut the frame section, 23 ft. in length, with this machine, it was necessary to use 32 ft. of track and make some changes on the torch and tracer mountings. This was done to accommodate the extended tracing table which was positioned outside the standard table and parallel to the cutting table. Two 16-ft. lengths of rail are now used to permit enough longitudinal travel for cutting the 23-ft. long slab. The tracing table is extended beyond its normal position, and an extension for the manual tracer is just long enough to take care of this extension. The cutting table, and location of the 34½-in. wide steel slab, is



The torch and extension arm, showing cut in progress on a frame window



View of the frame from the front end taken when the cutting was completed



The machine gas-cut locomotive frame—One of four for a mallet-type locomotive

closer to the Travograph rails than standard practice; the torch, however, is extended towards the rails to accommodate this change.

The steel slab was preheated before cutting, a brick furnace being used as shown in one of the illustrations. Asbestos sheets bridged the bricks and covered the slab by lapping the joints. Preheating was accomplished by two oil burners. The cutting torch was directed by the manual tracer following a soapstone pencil layout on the top of the steel tracing table.

The slabs were preheated with oil burners for about 8 hours, slowly bringing them up to a temperature of 600 deg. F.; this was checked carefully by a pyrometer to eliminate guesswork. The asbestos sheets which formed the top of the furnace were removed to expose only the section being cut and were replaced as soon as the cutting on the section was completed. Seven starting holes were pierced for the starting of cuts in the openings. Test coupons were cut from two different points specified by the metallurgist. The data given in the table were obtained on this job. The weight of the slab at the start was 14,850 lb., while the estimated weight of the completed frame section is 5,000 lb.; this indicates that approximately two-thirds of the material in the slab may be worked up into miscellaneous forgings.

Performance Data in Machine Gas-Cutting Mallet Locomotive Frames*

Cutting time, hrs. and min., approx.	3-15
Cutting tip, type	Style 144, No. 6
Oxygen pressure, lb.	60
Acetylene pressure, lb.	4
Cutting speed, in. per min.	6
Linear feet cut	97
Oxygen consumption, cu. ft.	1,055
Acetylene consumption, cu. ft.	63
Oxygen consumption per linear foot, cu. ft.	10.87
Acetylene consumption per linear foot, cu. ft.	0.65
Ratio of oxygen to acetylene	16.75:1

* Air Reduction Sales Company, New York, Airco-DB No. 1 Travograph used.

Compound for Oil, Water and Steam Lines

The Kenite Laboratory, 83 Murray Street, New York, has recently introduced into the railroad field two products known as Kenite Joint Compound, for use on steam, air and water lines in power plants and on locomotives and cars, and Kenite Oil Pipe Plastic for use wherever it is desired to stop oil leakage. Both of these products are plastic in character, an essential difference being that the joint compound remains plastic at all times, while the

oil pipe plastic hardens in contact with the atmosphere while remaining semi-plastic underneath the surface.

The joint compound is especially adapted to steam and air lines with threaded or flanged connections under pressure. On coach heating lines it has been used successfully on six-inch gaskets under 85 lb. pressure, and in power plants on steam lines and boiler studs under 500 lb. pressure. It is also used on air, water and steam lines and on boiler studs on steam locomotives and for yard and car air lines.

Used as a joint compound on threaded pipe connections it has peculiar qualities of elasticity which make wicking unnecessary by providing a joint-sealing material that does not set up hard, but remains flexible and adjusts itself to the contraction and expansion of the joint. It is said that its adhesive qualities prevent it from breaking loose from the pipe surfaces and passing through the pipe. This feature is of importance in locomotive piping, in order to prevent interference with the operation of such devices as triple valves, power reverse gears, etc.

The oil pipe plastic has been applied successfully in the railroad field as a sealing medium on joints which are required to be oil-tight, such as oil lines and cover plates on Diesel engines.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

What is the Color of Overheated Crown Sheets?

Q.—What color would the fire side of the crown sheet be if the sheet had been touched up just enough to spring the head of the crown bolts? What color would the crown sheet be on the water side, or what indication would there be on the water side?—S. A. W.

A.—The overheated areas of crown sheets show a deep blue color, which is characteristic of overheating.

Why Flange Knuckles Crack

Q.—What causes the backhead of a locomotive boiler to crack at the knuckle of the flange? Sheets are of an alloy content. Can it be remedied?—G. J. F.

A.—The cracking of the boiler sheets at any point is due to expansion and contraction strains set up by the buckling effect on portions of the boiler not free to expand and contract with heating and cooling of the boiler.

The expansion and contraction of the boiler shell and firebox wrapper sheet is not the same as that of the boiler tubes and firebox sheets. This unequal expansion and contraction between the shell on the outside and the tubes and firebox on the inside causes a working of the backhead, the strains of which are carried by the knuckles at the sides of the backhead.

The proper handling of the locomotive to reduce to a minimum the actual causes of expansion and contraction, such as the excessive use of the blower, the blowing down of the boiler too soon after fires are drawn, the use of cold water in washing boilers, the forcing of the fire too rapidly, would aid considerable in the prevention of cracked backheads.

A practical remedy is to reenforce the knuckle with a patch on the outside, or, when applying new backheads, reenforce the knuckle with a plate on the inside of the knuckle; this reenforcing plate strengthens the knuckle and transfers the strains out into the flat plate, thus preventing the cracks from starting.

A Correction — Reason for Removing Flexible Staybolt Caps

Q.—Referring to your January, 1938, issue of the *Railway Mechanical Engineer*, page 37, "Locomotive Boiler Questions and Answers": Item (e) of this question is not properly answered. Item (e) in this issue reads as follows: "Staybolt caps shall be removed or any of the above tests made whenever the United States inspector considers it desirable in order to thoroughly determine the condition of staybolts or staybolt sleeves."

The I. C. C. rule on this matter reads as follows: "Staybolt caps shall be removed or any of the above tests made whenever the United States inspector or the *railroad company's inspector* considers it desirable in order to thoroughly determine the condition of staybolts or staybolt sleeves."—J. R.

A.—J. R. is correct. Rule 23 (e) as shown on page 37 of the January, 1938, issue should be corrected to include both United States and railroad company's inspectors as stated in the question.

Thickness of Dome Cap Calculated

Q.—Kindly advise me as to the method of determining the thickness of a dome cap of a locomotive boiler.—A. D.

A.—The thickness of a locomotive dome cap, which is an unstayed flat head, unpierced and is rigidly fixed and supported at the bounding edges by bolts or studs, can be computed from the formula

$$t = a \sqrt{\frac{0.162\ P}{S}}$$

where t = thickness of plate, in.; a = diameter or short side of the area measured to center of the dome-cap gasket, in.; P = maximum allowable working pressure, lb. per sq. in.; TS = ultimate tensile strength, lb. per sq. in., stamped on the plate as provided for in the specification for the material; and S = allowable unit working stress, (TS/factor of safety), lb. per sq. in.

Assume a locomotive boiler having the following characteristics: Steam pressure = 225 lb. per sq. in.; diameter of dome gasket = 25½ in., I. C. C. factor of safety = 4; and tensile strength of steel = 55,000 lb. per sq. in. Thus, we have S = 55,000/4 = 13,750 and

$$t = 25.5 \sqrt{\frac{0.162 \times 225}{13{,}750}} = 1.3 \text{ in.}$$

The required thickness of the dome cap would be $1\frac{5}{16}$ in.

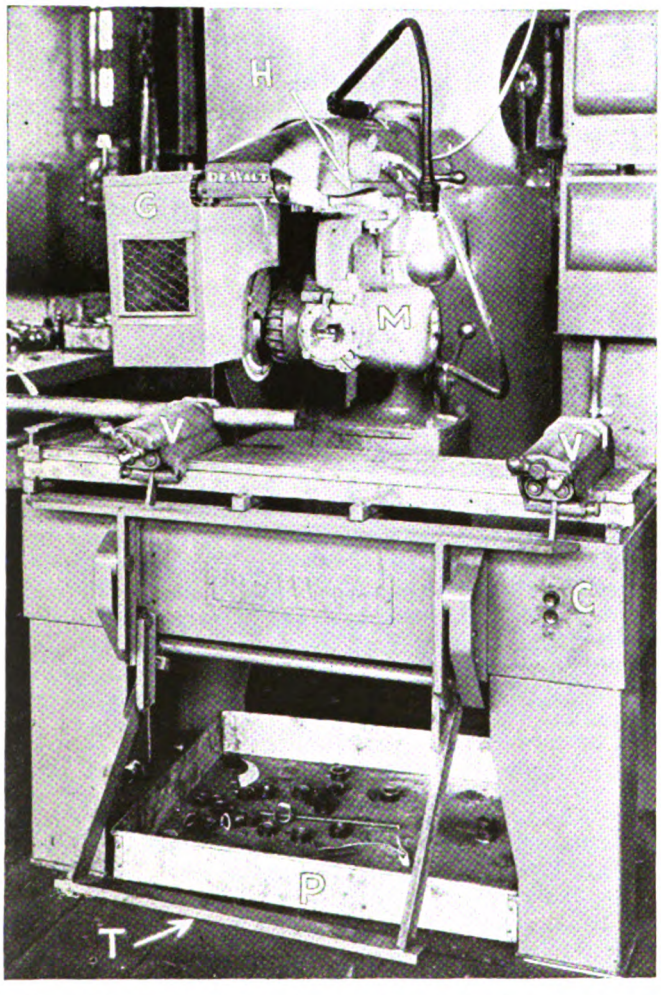
Dome caps of locomotive boilers are, as a rule, finished where the caps are secured to the dome. This finish would require the plate, from which the dome cap was made, to be at least $\frac{1}{16}$ in. thicker than the thickness of the finished portion of the cap; thus, the thickness of the plate for the dome cap herein calculated would be $1\frac{3}{8}$ in.

With the Car Foremen and Inspectors

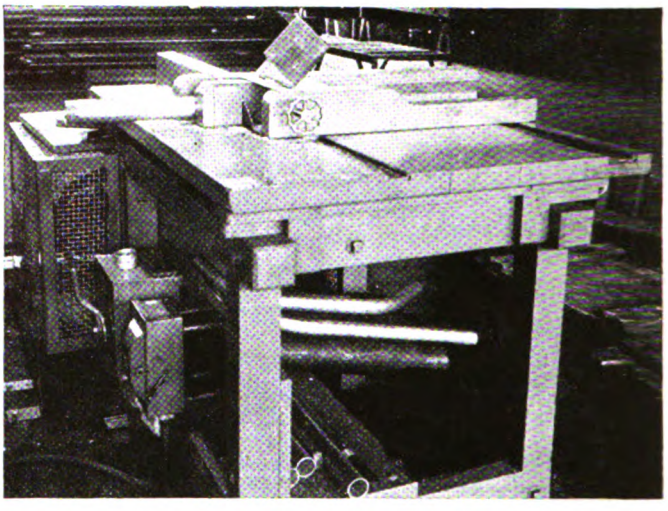
Pipe-Cutting Machines At Milwaukee Shops

Two compact and efficient pipe-cutting machines which are giving exceptionally good service at the Chicago, Milwaukee, St. Paul & Pacific passenger car shops, Milwaukee, Wis., are shown in the illustrations. The first of these is a metal-cutting friction saw, developed by the De Walt Abrasive Products Corporation, Lancaster, Pa., the machine illustrated being particularly well adapted for cutting steel and brass pipe because adequate power is available to make the cuts quickly, square with the centerline of the pipe and leaving only a thin fin which may be readily broken off by hand. All pipe sizes up to 2½ in. may be cut.

Referring to the illustration, the construction of the machine is apparent. The pipe is held square with the abrasive wheel in one or two vises *VV* as may be necessary. The carborundum abrasive wheel or disc is 18 in. in diameter and ⅛ in. thick, being mounted on the shaft of a compact high-speed electric motor *M*, which operates at 3,500 r.p.m. and develops 7½ hp. The motor is supported in an indexed bracket, which permits making angle cuts about a horizontal axis, the upper part of the bracket being capable of transverse movement in V-ways in the upper head of the machine. This head is clamped to a vertical post at the rear of the machine, thus permitting adjustment for angle cuts about a vertical axis. Hand feed for the cutting operation is obtained by means of handle *H*, which operates a sprocket wheel and chain drive connected to the motor-supporting bracket. Foot treadle *T* gives quick release of the vise pressure for adjustment of pipe position and a galvanized pan *P* catches the scrap pipe ends. The machine is easily started and stopped by means of push buttons *C*.



De Walt metal-cutting friction saw installed in the Milwaukee passenger car pipe shop



Milwaukee shop-made saw for use in cutting copper and aluminum tubing

The special sheet-metal guard *G* was developed to furnish additional protection to the operator in case of breakage of the wheel. A hinged panel in one side of this guard gives ready access to the wheel when necessary to make a change and the safety glass permits inspection of the sawing operation without eye hazard. When the glass becomes clouded by action of the abrasive particles a new square may be inserted at small cost. The shielded electric light installed on the machine helps production by giving excellent illumination just where it is needed.

Cutting Soft Metal Pipe

For cutting soft metal pipe and tubing at the Milwaukee car shops, the machine shown in the second illustration is also used to advantage, consisting of a substantial wood table with well-braced legs which carries a self-contained 12-in. circular wood saw, belt driven from a 5-hp. electric motor mounted at the back of the machine with a starting switch and control lever on the side. The driving motor is fully guarded by means of a metal frame and wire screen, as illustrated.

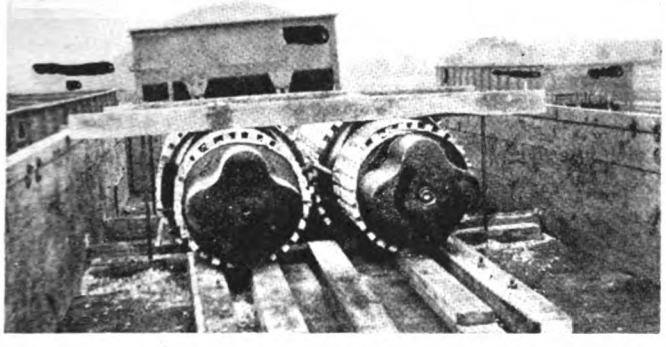
The table top is approximately 32 in. by 43 in., and located at a convenient height of about 36 in. above the shop floor. Two metal slides inset in the table top, as

illustrated, serve as guides for a wood carriage which moves at right angles to the saw cut and is equipped with a simple wood vise, operated by a screw and hand wheel. The machine is designed to cut either copper or aluminum tubing in all sizes up to 2 in., and the operation consists simply of placing the tubing in the hand-clamp or vise and feeding it by hand to the cut-off saw which makes the cut smoothly and easily.

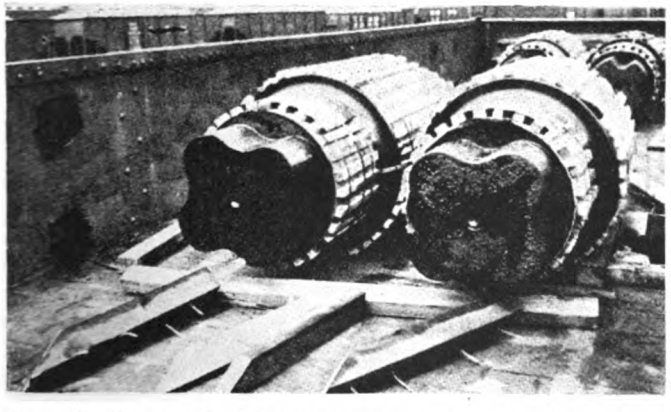
In practice it was found necessary to furnish protection against flying chips; consequently, the hinged metal guard, shown in the illustration, was applied in such a way that while making the cut it is turned down over the saw groove and deflects or catches all chips. As in the case of the other machine, the advantage of this one is that the saw cut is made quickly, square with the pipe centerline and with practically no fin.

Inspection of Lading In Open-Top Cars

One of the most important duties of a car inspector is to inspect carefully the lading placed in open-top cars before it is allowed to leave despatching terminals to see that it is securely braced to prevent shifting of the load while in transit. The blocking used to secure the lading should be checked to see that it conforms to the minimum requirements specified in the A. A. R. Loading Rules, and where there is no specific rule or figure in the rules to cover a specific type of lading the inspector should, if possible, call the matter to the attention of his foreman



Twin rolls loaded in accordance with Sketch 1 of Fig. 65-A of the loading rules—Note exceptionally long bodies tied down in accordance with Sketch 2—With ordinary train handling this load will stay in position



Two rolls that were loaded in the center of the car, their combined weight being in excess of 20,000 lb. but not in accordance with Sketch 1 of Fig. 65-A—Note Item *B* split and broken and Items *C* torn loose

Minimum Requirements for Securing Mill Rolls, Lengthwise-Gondola Cars*

Item	No. of Pieces	Description
A	.....	Brake wheel clearance. See Fig. 2 of the Loading Rules.
B	2	4-in. by 4-in., hardwood, length to suit, rolls less than 20,000 lb. 4-in. by 6-in., hardwood, length to suit, rolls 20,000 lb. and over. Secure each Item *B* with 2 bolts, ¾-in. diameter with washers, through floor and Items *F*. When Items *B* are less than 3 in. thick, they must completely fill space between the shoulders of rolls and Items *G*. See sketch 1.
C	6 per roll	4-in. by 4-in., hardwood, wedge shaped, rolls less than 20,000 lb. Secure each with five 40-D nails. 4-in. by 6-in., hardwood, rolls 20,000 lb. and over. Secure each with 2 bolts, ¾-in. diameter, with washers, through floor and Items *F*. Increase length of center item, when necessary, to admit of applying nails or bolts. When Items *G* are used, Items *C* and *G* must be of equal height. See sketch 1.
D	2 per roll	4-in. by 4-in., hardwood, rolls 28-in. diameter or less. For rolls over 28-in. diameter, height of Items *D* must be one-seventh the diameter of roll, maximum height 10 in., width equal to height, length equal to two-thirds the length of body of roll. Secure to floor with 40-D nails.
E	Each Item *D* 6 ft. long or less, 3. Each Item *D* over 6 ft., add 1 for each additional 4 ft. or less in length. Rolls weighing 20,000 lb. or over, 2 each, Item *D*.	4-in. by 4-in. by 12-in., hardwood, wedge shaped. Secure with 40-D nails. Two-thirds of Items *D*, minimum thickness 2 in., 4 in. wide, hardwood. When applied in two or more sections, bottom section must be long enough to fill space between Items *D* and car sides, nailed to floor with 30-D nails. Nail top sections to the one below with 30-D nails.
F	6 per roll	2-in. by 4-in. by 18-in., or ⅜-in. by 4-in. by 6-in.

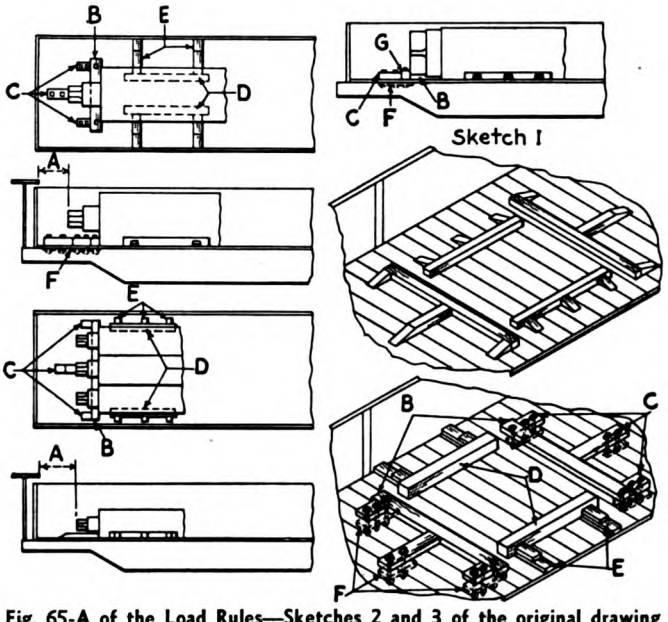


Fig. 65-A of the Load Rules—Sketches 2 and 3 of the original drawing are omitted

G	2 per roll	6 in. wide, high enough to provide 4-in. bearing against end of roll, hardwood, length to suit. Secure each with 2 bolts, ¾-in. diameter with washers, through floor and Items *F*. Required only when Items *B* are less than 3 in. thick. See sketch 1.

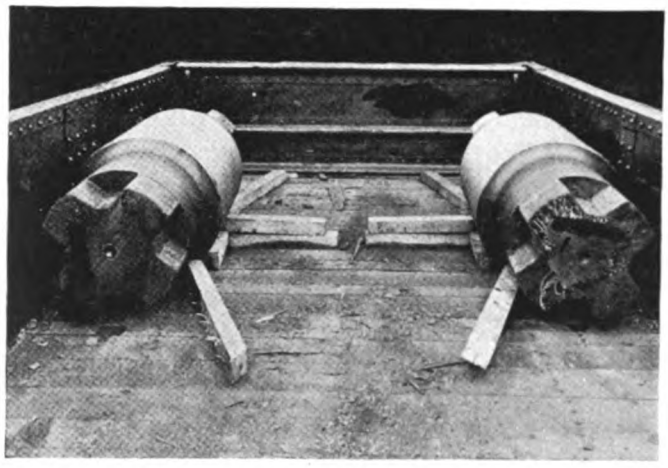
When loaded two or more, side by side, and their combined weight is 20,000 lb. or more, Items *B* and *C* must be bolted. Items *D* and *E* required only on sides of rolls next to car sides.

Rolls with short bodies, 24 in. diameter and over, and exceptionally long bearings, must be secured as per either sketches 2 or 3 in Fig. 65-A of the Loading Rules.

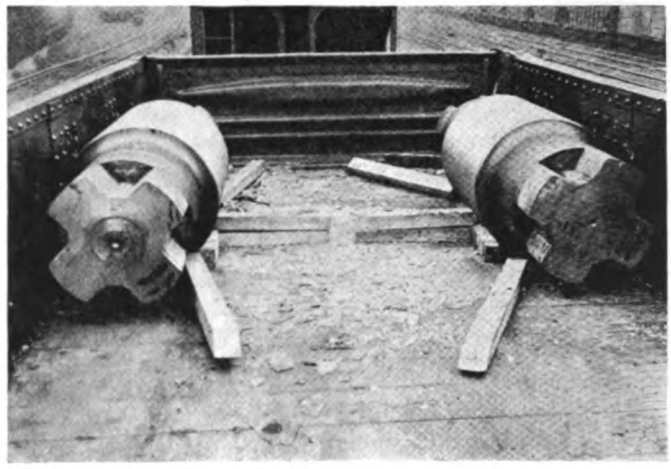
Finished portions of rolls or bearings must be protected to prevent damage.

See General Rules for further details.

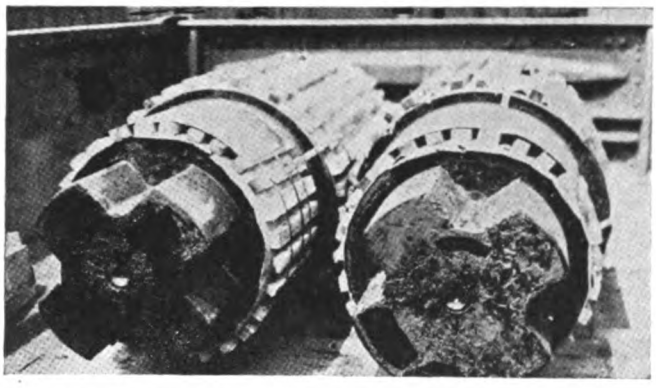
* All items and sketches mentioned in this table are shown in Fig. 65-A of the A. A. R. rules governing the loading of commodities on open-top cars, page 154 of 1937 revised edition, effective January 1, 1938.



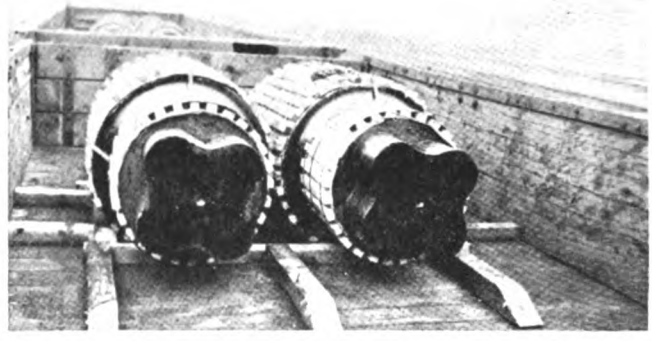
End blocking which should have been applied in accordance with Sketch 1 has been torn loose; obviously, one or both rolls will work past the side blocking and shift toward one side of the car on a curve



The combined weight of these rolls is in excess of 20,000 lb. and they should have been loaded in the center of the car in accordance with Sketch 1 of Fig. 65-A of the Loading Rules



Two rolls weighing eight tons each with no end protection and only a small block slipped under each side of the rolls to prevent them from rolling toward the car side—If they had shifted against the side of the car they would no doubt have caused an accident by derailing or upsetting the car



This is a good looking load; however, it will not meet the requirements of Fig. 65-A of the Loading Rules because one Item *C* is required directly in the center of each roll. This is important because the end thrust of each roll is confined to this point and, unless protected, Item *B* will split allowing the load to become loose

so that a careful study can be made of the load. If no foreman is available he should not permit the load to depart in a train until he is firmly convinced that sufficient bracing and blocking has been provided to carry the load safely to its destination without damage to the lading or creating a hazard to the railroad.

A commodity that requires the greatest of care in handling is mill rolls, which range from 6 in. to 6 ft. in diameter. Modern rolling mills erected in many parts of the country have brought about the demand for larger diameter rolls, some of which weigh as much as 20 tons apiece. The requirements of former Fig. 65 of the A. A. R. Loading Rules were not sufficient to prevent these large-diameter rolls from shifting in transit with the result that several loads that had been secured in accordance with this rule were found shifted past their side blocking. Fig. 65-A was then developed and shows the minimum requirements for securing these rolls to prevent them shifting in transit, rolling over against the car sides and creating a hazard that is liable to cause the car to derail or turn over.

The accompanying illustrations show several cases where mill rolls were improperly blocked and where the requirements of Fig. 65-A of the loading rules were not followed at the place where the cars were loaded, making it necessary for the car inspector to bad-order the car and have the loads reblocked before allowing them to continue to their destination. While none of the rolls in the illustrations were damaged or caused an accident, this was no doubt prevented by the action of the car inspector in bad-ordering the cars before they actually shifted sufficiently to pass by the side blocking and roll towards one side of the car.

By carefully comparing the manner in which each of the illustrated loads were loaded with the reproduction of Fig. 65-A of the A. A. R. Loading Rules it will be observed that in only one case was the minimum requirements of the rules followed.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Disagreement as to Type Of Brake Beam Applied

On July 29, 1936, the Green Bay and Western repaired NATX car 1416 and in its bill showed that one new No. 15 A. A. R. brake beam had been applied. On

August 4, 1936, the Chicago, Milwaukee, St. Paul and Pacific removed the brake beam and in its repair card showed it to be an A. A. R. No. 2-plus beam.

The North American Car Corporation maintained that the repair card of the C. M. St. P. & P. acted as joint evidence, according to Rule 90, that a No. 15 beam had not been applied by the G. B. & W., and asked that the latter road reduce its charge to that for a secondhand No. 2-plus beam. However, the G. B. & W. contended that a new No. 15 had been applied on its lines and maintained that it had never been the purpose of joint evidence to prove that secondhand material had been applied, the purpose being to show that repairs might have been made which are not the owner's standard.

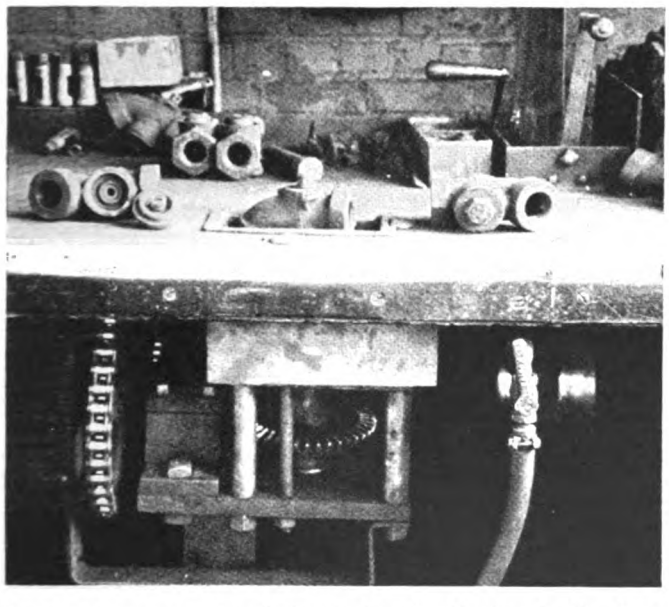
In rendering a decision on November 11, 1937, the Arbitration Committee stated: "While this is not a case of wrong repairs, the principle of Rule 90 applies, and the bill of the Green Bay and Western should be adjusted to a basis of a new No. 2-plus beam applied."—*Case No. 1759, North American Car Corporation versus Green Bay & Western.*

Angle Cock Cap Remover

Many of the angle cocks received at car shops for repairs have caps corroded or damaged, making their removal difficult, and considerable time is sometimes required in doing this work by hand. The mechanical cap remover, illustrated, was developed to overcome this trouble and has proven unusually efficient, removing all caps without trouble.

To remove the cap, the cock is placed, cap down, in a slot in the bench top. The hex nut on the cap will then be in a power-driven hex socket, located beneath the slot which holds the cock while the cap is being turned out. The device operates at slow speed so that the cocks can be placed in and removed from the machine while it is in motion; six caps per minute can be removed.

The device is powered from an overhead shaft through a combination of pulley, cone clutch, sprockets and gears to a vertical shaft on which is mounted a hex socket of size suitable for the work. The hex socket is located in the center of the slot and three inches below the bench top. The slot in the bench top is metal lined. Operation of the machine is controlled by a lever conveniently located on top of and to the rear of the bench and connected to the cone clutch.



Angle cock cap removing device used at the Northern Pacific shops, Brainerd, Minn.

Discussion of I. C. C. Rule 4*

M. E. Fitzgerald, general car inspector, C. & E. I.: There is quite a misunderstanding on the part of inspectors in connection with Rule 4. I have in mind the question of one stake on a car raked to destruction, the rule providing that two stakes on a car raked one-third of its depth are cardable. I understood Mr. Mehan to say at the last meeting that the association will put out an interpretation on that rule. We are really up against a problem on cars moving through interchange with one stake on a car raked to destruction, cut in two. I would like Mr. Mehan, if he would, to give us some idea as to what to do when we receive a car with one stake raked practically to destruction.

J. E. Mehan, assistant to superintendent car department, C. M. St. P. & P.: As I understand this rule, one stake or one brace on one side of a car damaged to destruction would not be cardable. That's the way I understand it. There must be two stakes damaged to the extent shown before it is cardable. Bear in mind that this limit of cardable defects in Rule 4 for open top cars was brought about by a study made where this sub-committee viewed hundreds of open-top metal cars, and it was really surprising to see the cars that came out from the owner's shop after having had the air brakes cleaned, or the boxes repacked, or the car repainted by the car owner. In other words, work done on the car that could only be done on a repair track and he allowed these cars to return to service with these posts in this condition, and it was from what the committee saw that this rule was framed. If the car owner didn't pay any attention to these defects why should you; if he didn't consider it detrimental enough to repair when he had the opportunity to do so, why should you; and it was on that basis that this limit was defined. There were cars with bulb stakes flattened right up against the side of the car just as though there never had been a bulb in it at all; still the car was repainted all over and nothing was done to straighten the stakes. The car owner didn't seem to mind as long as there were less than three so damaged or even cut, so I would say, from the reading of the rule, that where one post or one brace on the side of the car was damaged to destruction, or even missing entirely, it would not be cardable.

Mr. Fitzgerald: Every car foreman knows what Mr. Mehan has said is true. We write these rules and the rule is clear. It is true that thousands of cars are moving with one and two stakes flattened and the owners run them. The association, which merely represents the railroads in making and formulating these rules, writes a rule to which the president of the railroad has agreed, so why should we worry about them; why shouldn't we be honest and not have this difference of opinion at every terminal? Let's go along with what Mr. Mehan has said. There is quite a bit of discussion of this question throughout the country and you men can go a long way towards cutting out a lot of this useless carding. On the railroad I represent we are in a position to follow

* Abstract of a Discussion at the February Meeting of the Car Foremen's Association of Chicago.

up every defect card that's issued. I can bring you any number of defect cards for side stakes raked and damaged that have never been billed and never will be. We have followed them up for two or three years and I can produce a great many of them any time you want. The committee is doing a big job and is trying to help our inspectors. At large points, such as Chicago, the inspectors pass cars up in a hurry, but at the smaller points where the inspectors have more time they card these things and criticise the fellow in Chicago for not carding them. Let's cut out that foolishness. I think the committee is on the right ground when they cut out a lot of this useless carding.

Mr. Mehan: Perhaps the committee that is to recommend changes at the next meeting might ask that some interpretation be put in Rule 4 to amplify it in such a way as to make it clear if it is not clear. The A. A. R. has gone to great lengths in trying to make Rule 4 workable. As you all know, it is necessary that we have Rule 4 because of the trivial unfair usage defects that are really not detrimental to the car and are not repaired until the car is shopped for general overhauling. In the meantime, the car remains in service with a defect card on it. It becomes so illegible that nobody can read it, or it is lost off and the wrong railroad is finally penalized. Every inspector at interchange points is supposed to take a record of that defect card, and so we have to put something in Rule 4 to define the defects which would not be cardable in order to cut out this unnecessary defect carding and recording. It has worked very well, but it is a hard rule to write and make it satisfactory to everybody. No matter how you define limits you will always find questions of the kind Mr. Fitzgerald raises, and, of course, we cannot say that they are foolish questions. I think it would be better if we would petition the A. A. R. to give us some kind of a ruling in Rule 4 to define whether or not a post or brace damaged to destruction or missing entirely would be cardable so that that question would be settled forever.

J. Krupka, general foreman, C. B. & Q.: If we have a car with one post out and one post bent to the extent shown in Rule 4, would one or two posts be cardable?

Mr. Mehan: One post cut and one post bent on the same side of the car? If the post that's bent isn't bent to the extent defined in Rule 4 we don't care if the owner ever repairs it or not because it will never be cardable in interchange. If the post that's cut isn't cut to the extent shown and there is only one of them, it isn't cardable because it doesn't require any carding in interchange so that you and I will never be bothered with carding for two posts of that kind.

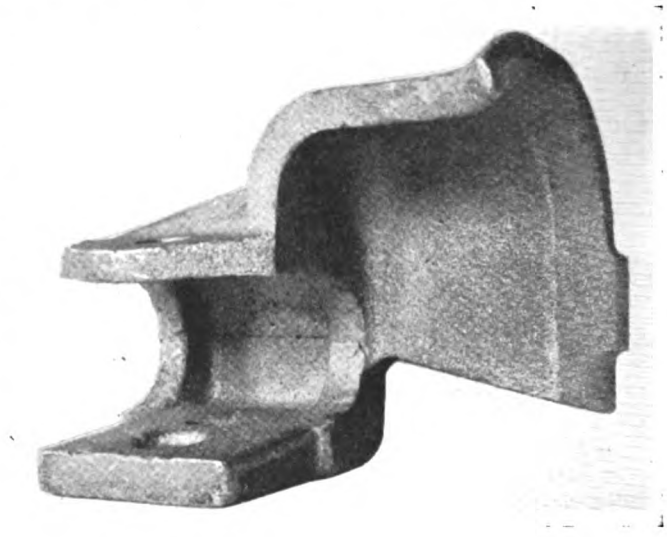
Mr. Krupka: The question was, one post is bent to the extent shown and other post is cut to the extent shown.

Mr. Mehan: Under the rule, the one that is bent to the extent shown is cardable, the other would not be. That would be my interpretation of the rule.

Mr. M. E. Fitzgerald: I quite agree with Mr. Mehan. We must, as car men, get away from this theory of technical interpretation and technical exceptions. If we can ever get to the point where we agree that the committee appointed to formulate these rules actually represent the roads, and then if you will turn to the page in the rule books where you will note your president accepted the position of the committee formulating these rules, then we can come to a common understanding and there won't be a condition such as confronts us now. Transportation men invariably tell me that no two car men agree on the rules. We have got to get to a point where these men accept the position of the committee. What's the use of you and me arguing when the president signs the book of rules and in that book he says that two stakes must be raked to a certain extent. I am not trying to force my personal opinions on you, I am trying to get all car men to agree that one thought, one idea, right or wrong, is the thing we ought to follow. In other words, if it is wrong let's follow the thought of the committee for one year. Better that than having a thousand diversified ideas of the rule. The rule to me is clear. I brought it up so that Mr. Mehan could interpret it and we would all have one thought on the matter and so this association can back it up.

Replacement Brake Hanger Bracket

Cast-steel U-section truck side frames which are equipped with obsolete or worn brake-hanger brackets can now be modernized by cutting off the old brackets and welding on the new replacement bracket, illustrated, which

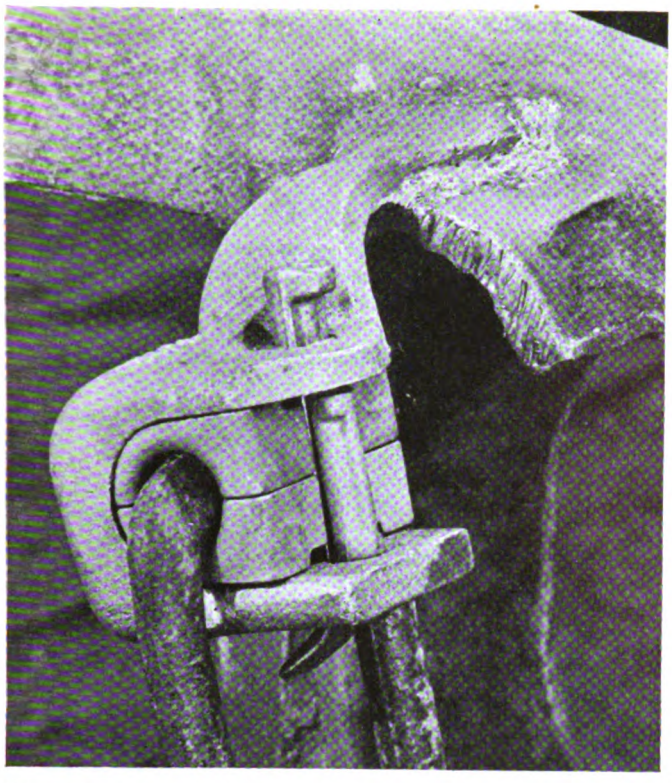


Replacement brake-hanger bracket before application to the truck side frame

has been developed especially for this purpose by the Illinois Railway Equipment Company, Chicago. The application is made by burning the old bracket from the truck frame with an acetylene torch approximately 3 in. from the centerline of the hanger, leaving a portion of the old bracket to which the new bracket may be welded by the electric-arc method. The new bracket is made of electric cast steel.

The hanger bearing portion of the replacement bracket is made in accordance with the latest A. A. R. 1937 design. The attachment portion is designed to replace any type of bracket now on the frame. The new replacement bracket is placed in the standard A. A. R. hanger location regardless of where the present brackets are located. This permits the use of a standard loop-type hanger instead of necessitating the use of several different designs and lengths of hangers.

Correct alinement of the replacement bracket is controlled by a jig, furnished by the manufacturer and used as shown in the drawing. The location of the bracket is gaged from the side-frame column opening, and variation in the side-frame column opening in relation to the brackets is taken care of by an adjustable stop gage on the jig. The jig is clamped to the side-frame column as shown; the bracket is then placed in the outstanding

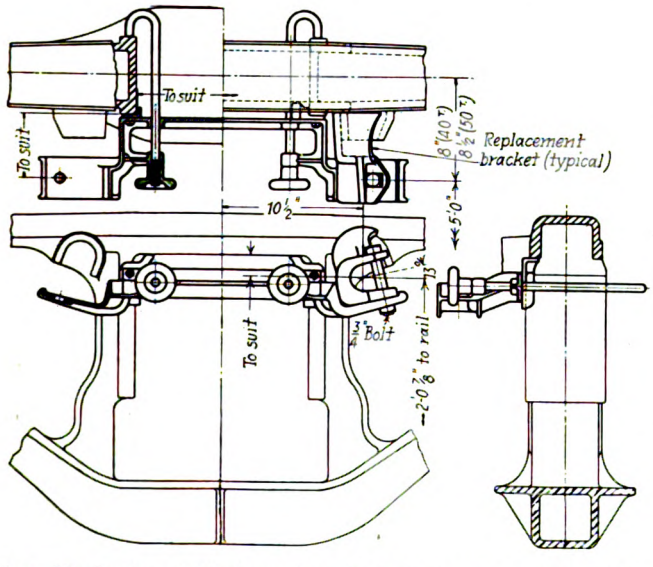


View of the bracket welded to the side frame and equipped with Mobile Type-A brake-hanger bearings and Perfection retainer key

arms of the jig, and the brackets are tack welded, after which the jig is removed and the welding completed.

The operation of burning off the old bracket and applying the new bracket consumes little time and can be accomplished with ordinary shop facilities.

Mobile Type-A brake hanger retainers are used in the



Assembly drawing which shows how the brake hanger bracket welding jig is applied and used

brackets to provide hanger bearings, and also to remove all wear from the side-frame brackets. The retainers are reversible and are normally held in position by Perfection retainer keys, a new improvement over the bolt-holding means previously used for securing the retainers in position. The tapered key serves as a drift to force the retainers back into the bracket, and, together with the key adapter, completely fills the holes in the bracket. The key is of ductile drop-forged steel, is readily bent in locked position, and can be removed and reapplied many times.

Questions and Answers On the AB Brake

Brake Cylinders (Continued)

304—*Q.—What test should follow the application test?* A.—The brake-pipe leakage test.

305—*Q.—How is this test made?* A.—Make a further brake-pipe reduction of 15 lb., and move the device handle to lap position.

306—*Q.—What then should be observed?* A.—The pressure on the brake-pipe gage, leakage being indicated by a drop in pressure.

307—*Q.—What leakage is permissible?* A.—The drop should not exceed 2 lb. in 1 min.

308—*Q.—What action is noticeable during this test?* A.—A slight pumping action of the emergency piston, indicated at the quick-action exhaust.

309—*Q.—Does this affect the leakage test?* A.—It will in no way affect this test.

310—*Q.—What test follows the brake-pipe leakage test?* A.—The auxiliary-reservoir leakage test.

311—*Q.—How is this test made?* A.—Watch the brake for 1 min. If a release is obtained in less time, it indicates leakage of auxiliary-reservoir pressure.

312—*Q.—To what may such leakage be attributed?* A.—To a leaky graduating valve, slide valve, auxiliary reservoir or pipe connections.

313—*Q.—What defect in the test device would bring about a release?* A.—A leak into the brake pipe past the rotary valve.

314.—*Q.—What test should follow the auxiliary-reservoir leakage test?* A.—The release test.

315—*Q.—How is this test made?* A.—By moving the test-device handle to the No. 2 position.

316—*Q.—What effect does this have?* A.—It increases the brake-pipe pressure through a restricted opening in the test-device rotary sufficiently to force the piston and slide valve to release position.

317—*Q.—What time should be required to accomplish the release?* A.—On cars whose length is 50 ft. or less, 20 sec., plus 5 sec. for each pound of brake-pipe leakage. On cars 51 to 60 ft. in length, 25 sec. plus 10 sec. for each pound of brake-pipe leakage. On cars 61 to 70 ft. in length, 30 sec. plus 15 sec. for each pound of brake-pipe leakage.

318—*Q.—What precaution should be taken during this test?* A.—It must be observed that the supply-line pressure does not drop below 70 lb.

319—*Q.—In the event of any such variation, what should be done?* A.—Means should be provided for maintaining the supply pressure at 70 lbs. and the test repeated.

320—*Q.—What test follows the release test?* A.—The service stability test.

321—*Q.—What must be done before beginning the test?* A.—Move the device handle to position No. 1, charging the brake pipe and reservoirs to 70 lb.

322—*Q.—When the system is fully charged, how is the test conducted?* A.—Move the device handle to position No. 5, reducing the brake-pipe pressure 20 lb. and then return to lap position.

High Spots in
Railway Affairs . . .

Eastern Railroads Get Passenger Fare Increase

On July 5, the Interstate Commerce Commission reversed its 6-to-5 decision of last April and authorized the eastern railroads to increase their basic coach fares from 2 cents per mile to 2.5 cents a mile for an experimental period of 18 months. This readjustment, which was made in the midst of the vacation season, naturally caused all sorts of repercussions. The fact that the railroads need greater revenues is, of course, not questioned. The fear on the part of some of the commissioners is that this increase in rates will drive business to competing carriers and will result in less net for the railroads than if the 2-cent-fare had been maintained. The question arises, however, whether such a determination is not purely a managerial function which should be made by the railroad managements which are thoroughly familiar with the passenger business, and which must carry the responsibility for the results, rather than by the commissioners who are more or less far removed from the practical problems involved. The Commission also emphasizes the point that coach service has been greatly improved since its decision in 1936 that coach fares should not exceed 2 cents a mile. Heavy investments have been made in these improvements, and this fact is recognized and appreciated, even by casual travelers.

"Road Hogs"

Railroad brotherhood magazines in recent years have contained complaints from some of their members about the "road hogs;" that is, men, who because of their seniority and the peculiar rules under which they operate, have been able to make unusually large wages at the same time that men down the list have been furloughed or have worked for only a small part of the time. It is a matter of record that some of these "road hogs" are paid for as high as 40 days or more of work in a month. Interestingly enough, this phase of the wage question promises to be integrated into the present wage controversy, but not by the railroads or by the labor leaders. It is coming rather from railroad economists, the newspapers and the railway press. The furloughed men and those working on short time have lacked leadership in protecting their interests, but are rallying as they recognize that outside influences are sympathetic to their needs. With the limelights focusing upon unfair and punitive working rules, which cause the railroads to spend millions of dollars each year for work not done, it looks as if there might be an overhauling of the working agreements which were adopted at a time when operating conditions were very different from what they are today. It is high time that they were revised to conform to modern operating conditions. If so, then money, which is now being spent for work which is not done, can be diverted to productive work which will call back to their jobs many workers in the equipment and road maintenance departments. There is plenty of such work which must be done if the funds can be found.

Will the Rutland Follow the Circus?

The roustabouts put the circus out of business, even though the performers were willing and anxious to take a cut in their salaries to keep it going. What will happen on the Rutland? The federal judge has said that the court could not permit the receiver to operate that railroad many days at a loss of $2,400 a day. Officers of the 413-mile road have accepted successive salary slashes since May 5, totaling about 56 per cent. Citizens in communities along the line are naturally greatly disturbed over the prospects of abandonment, and are seeking to find ways and means of keeping the road in operation. The suggestion has been made that, in conjunction with various other measures, a voluntary wage cut on behalf of the employees would help to insure the operation of the road for a time at least. Doubtless, the workers would be glad to make a reasonable compromise to protect their jobs. The labor union spokesman, however, insists that such proposals can be discussed only under the provisions of the Railway Labor Act, proceedings for which are already under way, which may stretch out over several months. As a result the workers on the Rutland may soon find themselves entirely off the payroll.

Deadheads

The passenger traffic report made by Co-ordinator Eastman's Section of Transportation Service in 1935 estimated that passenger transportation issued gratis annually was equivalent to at least 50 million dollars. In the following year, a compilation made by the Bureau of Statistics of the Interstate Commerce Commission, and covering the first quarter of 1936, indicated that by far the largest percentage of those receiving free transportation were employees, or members of their families, of the carrier reporting. A recent report of the same Bureau, covering the year 1937, estimates that free transportation to the value of almost 25 million dollars was given to the employees of other carriers and their families and to persons not employees of carriers nor members of employees families. Obviously, the discontinuance of passes to employees of other carriers or to non-employees would not save the railroads this amount of money. The report is presented as a matter of information without recommendations.

The Wage Controversy

The Brotherhood of Railroad Trainmen broke away from the Railway Labor Executives Association some time ago, and is now holding separate conferences with the Carriers Joint Conference Committee in the negotiations on the proposal to reduce wages 15 per cent. The American Train Dispatchers Association and the Order of Sleeping Car Conductors are not participating, since they were not served notices of a reduction on July 20. There is apparently no possibility of agreement between the leaders of the workers and the managements, and the next step will be to appeal for mediation. Just when this may be done was not evident when this was written. The labor leaders apparently intend to do all they can to slow up the progress of the controversy, in the hope that improved business conditions may help their case when it is finally settled. Unless something unforeseen occurs, the controversy promises to drag along for several months. That all of the workers are not in sympathy with the steps their leaders are taking is quite apparent. It would be interesting, also, if some unbiased public authority would judicially pass upon the correctness of the absurd statements that are now being made for public consumption, and quite apparently, for propaganda purposes.

Railway Mail Service Passes Century Mark

On July 7, 1838, Congress approved of an act designating every railroad in the United Sates as a post route. Before that time the railroads had carried mail for contractors who transferred it from stage coaches and other agencies because of the more expeditious service offered by the new competitor. July 7 of this year was, therefore, observed as the centenary of railway mail service on an official basis. There has been considerable controversy as to the time and place of the first use of railway mail cars on which the mail was sorted in transit. Two mail cars, equipped for sorting mail, were built by the Hannibal & St. Joseph (now a part of the Burlington lines) in 1862, and these cars were placed in service on July 26 of that year, operating between West Quincy across the state of Missouri to St. Joseph. Similar service was inaugurated on the Chicago & North Western, between Chicago and Clinton, Iowa, on August 28, 1864. Apparently, mail was sorted on trains considerably earlier than these two dates, envelopes being in existence post marked on the Boston & Albany in 1857.

Among the Clubs and Associations

Eastern Car Foremen's Outing

THE Eastern Car Foremen's Association held its annual golf tournament and field day at the Racebrook Country Club, New Haven, Conn., on Thursday, July 14. Railroad and supply men from the eastern and New England districts made up the total attendance of about 275 members and guests. Numerous events were held to provide entertainment for those in attendance. The golf tournament, as usual, held the spotlight with seven prizes for the principal winners. These were as follows: Low gross, Harry Nunn, B. & A.; Class A—Low gross, T. M. Ferguson, American Arch Company; low net, C. E. Bryant, Jr., Johns-Manville Corporation. Class B—low gross, L. C. Haigh, Magor Car Corporation; low net, E. L. Brown, B. & O. Class C—low gross, W. P. Brennan, Fabreeka Products Company; low net, W. L. Giles, Ellcon Company. In the putting contest for golfers G. W. Rink, Reading, was the winner and in the putting contest for non-golfers first prize was won by C. A. Hillers, L. C. Chase Company. The general arrangements for the outing were carried out under the direction of J. P. Egan, president of the association; F. H. Becherer, general chairman; A. E. Calkins and R. Sonquist, vice chairman, and 11 committee chairmen.

Mechanical Conventions

THE Committee on Co-ordination of Mechanical Conventions met at the Hotel Sherman, Chicago, Monday, July 25, F. P. Roesch presiding. The following associations were represented: Car Department Officers, International Railway General Foremen, International Railway Master Blacksmiths, Master Boiler Makers, Railway Fuel and Traveling Engineers and Allied Railway Supply Association. In accordance with recommendations made by the General Committee of the Mechanical Division, A. A. R., it was decided that no conventions of these associations be held this year. In order, however, to avoid any break in the continuity of the proceedings and the committee reports and to maintain them up-to-date, it was decided that open business meetings of the officers and committees of the various associations represented be held at the Hotel Sherman on Tuesday, September 27, and if necessary the meetings be continued over Wednesday, the 28th. Some of the associations have so many reports to discuss that it will be difficult to dispose of them, even in the two-day period.

Announcement was also made at the meeting that the American Railway Tool Foremen's Association will unite with the International Railway General Foremen's Association. The suggestion was also made that efforts be made to revive the International Railway Master Blacksmith's Association, affiliating it with the International Railway General Foremen's Association.

American Welding Society Annual Meeting

THE annual meeting of the American Welding Society will be held at the Book-Cadillac Hotel, Detroit, Mich., October 16 to 21. The President's reception will be held on Sunday afternoon, October 16, while the technical sessions will begin at 9:30 a. m., Monday, October 17. The tentative program includes the following papers:

MONDAY, OCTOBER 17

Afternoon

Arc Welding as Influenced by Shop Preparation, Tools, Jigs and Fixtures, by M. S. Evans, American Car & Foundry Company

Physical and Chemical Properties of the Nickel-Iron Alloys Formed in the Welding of Nickel Clad Steel, by W. G. Theisinger, Lukens Steel Co., J. H. Deppeler, Metal & Thermit Corp., and F. G. Flocke, International Nickel Co.

Weldability of Medium Carbon Steels, by R. W. Emerson, Westinghouse Electric & Manufacturing Co.

The Effect of Current, Pressure and Time on the Shear Strength and Structure of Spot Welds in the Aluminum Alloys, by G. O. Hoglund and G. S. Bernard, Jr., Aluminum Company of America

TUESDAY, OCTOBER 18

Morning

Flame Cutting, by J. J. Crowe, Air Reduction Sales Company

Weld Penetration, by John Hruska, chief metallurgist, Electro-Motive Corp.

Bronze-Welding, by W. S. Walker, The Linde Air Products Company

Some Electrical Charactersitics of Arc, by Dr. C. G. Suits, Research Laboratory, General Electric Company

Afternoon

(Joint Session with American Society of Mechanical Engineers)

Brazing Tubes in High-Pressure Boilers with Silver Alloys, by A. W. Weir, New York Central, and H. M. Webber, General Electric Company

WEDNESDAY, OCTOBER 19

Morning

Recent Developments in Welding of Machine Tool Structures, by L. F. Nenninger, chief engineer, and W. A. Maddox, welding supervisor, The Cincinnati Milling Machine Company

Symposium on Copper Alloy Welding

Progress in Copper Welding, by Ira T. Hook, research engineer, and Clinton E. Swift, welding engineer, American Brass Company

Testing of Spot Welds on Copper-Base Alloys, by D. K. Crampton, M. L. Wood, and J. C. Babin, Chase Brass and Copper Co.

Carbon Arc Welding of Silicon Bronze, by E. S. Bunn and J. R. Hunter, Revere Copper and Brass, Inc.

A Quick Shop Test for Quality of Weld and Its Correlation with the Standard Tests, by W. J. Conley, The University of Rochester

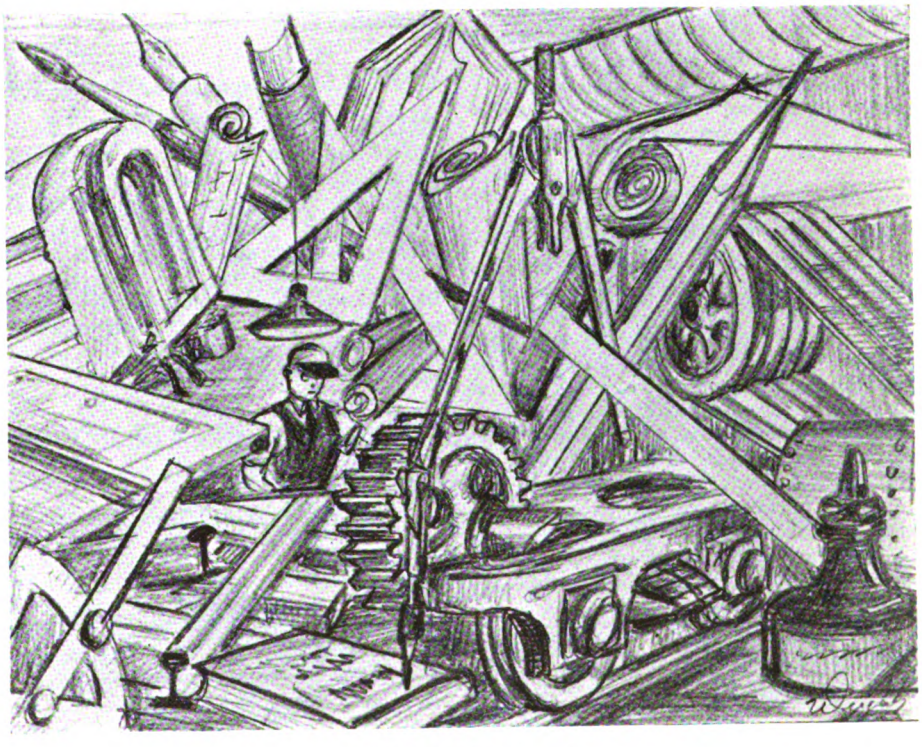
FRIDAY, OCTOBER 21

Morning

Railroad Session

Welding in Car Construction, by A. M. Unger, Pullman-Standard Car Manufacturing Company

* * *



The Draftsman's Dream

"The Drawing Office During a Passenger-Car Program," by Fred Wiegratz, draftsman, C. M. St. P. & P., Milwaukee, Wis.



*The "Flying Scotsman" trains of the London & North Eastern at Stevenage, England**

NEWS

C. M. & St. P. Enlarging Enginehouse at St. Paul

THE Chicago, Milwaukee, St. Paul & Pacific has awarded a contract to the Okes Construction Company, Minneapolis, Minn., for the construction of a 30-ft. addition to three stalls of this company's enginehouse at St. Paul, Minn., consisting of new concrete pits, brick walls on pile foundation and a frame roof. The total cost of this work will be approximately $30,000.

A. S. M. E. Committee on Rubber and Plastics

A committee on rubber and plastics has been established by the Process Industries Division of the American Society of Mechanical Engineers which will deal with several phases of these industries, including mechanical applications, research on basic mechanical properties, processing equipment, and standards. Activities of the group will be beyond the normal range of other professional organizations in an effort to fill the present conspicuous gap in the mechanical field.

The committee will sponsor the presentation of papers at technical sessions of the regular national meetings of the A. S. M. E. Dr. F. L. Yerzley, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., is chairman of the rubber and plastics committee. The secretary is Dr. J. F. Smith of the Edward G. Budd Manufacturing Company, Philadelphia, Pa.

C. N. R. to Spend $14,000,000 for New Equipment

THE Canadian National will make new equipment purchases amounting to nearly $14,000,000 during the present year, according to J. L. Ilsley, acting Finance Minister at Ottawa. Of this amount a loan of $3,455,000 has been authorized by the House, the remaining three-quarters of the total to be raised by the railroad under powers granted by legislation passed some years ago.

G M C Exhibit at World's Fair to Include Diesels

A LARGE section of the General Motors Corporation exhibit at the New York World's Fair of 1939 will be devoted to Diesel-engine operations. In this connection, a complete 3,600-hp. streamlined Diesel-electric locomotive will be displayed for visitors to inspect. The field of transportation as a whole will be reviewed through scientific and educational exhibits sponsored by General Motors Research Laboratories, which will illustrate the contributions and achievements of research in transportation during the past 25 years.

B. & O. and Pullman to Streamline Capitol Limited

THE Baltimore & Ohio has concluded arrangements with the Pullman Company for the streamlining of the Capitol Limited, the roads all-Pullman train operating between Washington, D. C., and Chicago. The work will be started immediately, one set of the train's equipment being put through the shops first, to be followed by the other set as the first Capitol streamliner goes into service. Delivery of the first set is expected in the early fall.

The improved Capitol will follow the now-standard B. & O. pattern of streamlining, devised by Otto Kuhler, consulting engineer of design.

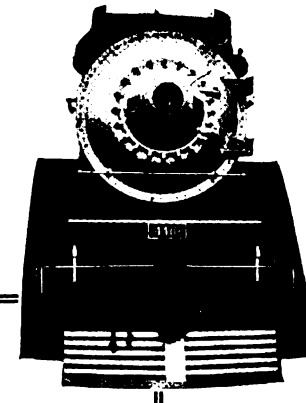
Awarded Honorary Degrees

L. W. BALDWIN, president of the Missouri Pacific, Edward M. Durham, Jr., chief executive officer of the Chicago, Rock Island & Pacific, and William C. Dickerman, president of the American Locomotive Company, classmates at Lehigh University in 1896, were awarded honorary degrees of Doctor of Engineering by that school at commencement exercises on June 14. The degree was conferred upon Mr. Baldwin in recognition of noteworthy contributions to the technique and economics of railway operation; upon Mr. Durham in recognition of noteworthy contributions to railway management; and upon Mr. Dickerman in recognition of notable contributions in the improvement of locomotive and other railway equipment. Messrs.

(Continued on next left hand page)

* To celebrate the jubilee of the railway race to Edinburgh in 1888 and the introduction of new rolling stock for the Flying Scotsman, the L. & N. E. on June 30 ran the original Flying Scotsman of 1888 from King's Cross to Stevenage, where the passengers were transferred to the new train. The locomotive of the former train, "The Stirling," having but one pair of driving wheels, was taken out of York Museum for the run, and the coaches were collected from all parts of the country.

MODERN LOCOMOTIVES MEAN...



•

Increased power at high speeds

•

Fuel economy

•

Lower maintenance

•

Higher operating standards

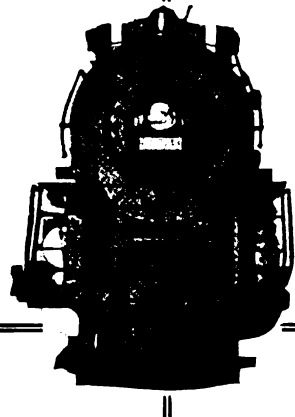
•

Greater gross earnings

•

Increased net profits

•



LIMA LOCOMOTIVE WORKS

LIMA LOCOMOTIVE WORKS INCORPORATED

INCORPORATED, LIMA, OHIO

Baldwin and Durham were graduated from Lehigh with a degree of civil engineer, while Mr. Dickerman was graduated with a degree of mechanical engineer.

Southern Pacific Car Workers Adopt Light Blue Uniforms

A LIGHT blue uniform with cap to match and with the name of the craft of the wearer inscribed upon it is now being worn by car inspectors, welders, coach cleaners, icemen, electricians, machinists, car oilers, boilermakers, carmen, truckmen, laborers, pipers, sheet metal workers and their helpers in Southern Pacific terminals. The innovation is a part of a general "spruce-up" campaign among employees whose work frequently brings them in contact with the public.

Petroleum Fair Exhibit to Feature Transportation Aids

How petroleum fuels and lubricants have aided in the maintenance of railroad service will be illustrated in a special display of the Petroleum Industry Exhibition at the New York World's Fair, 1939, which will feature the story of transportation from the ox-cart to the present day. The transportation exhibit will seek to show how the petroleum industry has aided railroading through the development of special oils and lubricants for locomotives, cars and other equipment and will indicate, further, how modern lubricants have freed engines and machinery from the limitations of friction at high speed.

The Petroleum Building at the fair will take the form of an equilateral triangle, covering an area of 28,166 sq. ft. Raised 20 ft. above the ground and rising to a height of 80 ft., the building will be supported by four large replicas of oil tanks.

Fourteen companies will participate in the petroleum exhibit.

"Coronation Scot" to Make American Tour

LORD Stamp of Shortlands, chairman of the London, Midland & Scottish (Great Britain), has announced that his road's streamline "Coronation Scot" will tour 3,120 miles over eight American systems next year, visiting 38 cities, and will later be exhibited at the New York World's Fair. Host to American transportation heads and other distinguished guests at a luncheon tendered by him in the Hotel Gotham, New York, as president of the Associated British & Irish Railways, Lord Stamp said that the London-to-Glasgow flier, which in trials set the British record speed of 114 m. p. h., will be brought here the last week in March to Baltimore, Md., where it will start on the following itinerary: Washington, D. C., Wilmington, Del., Philadelphia, Pa., Lancaster, Harrisburg, Pittsburgh, Wheeling, W. Va., Columbus, Ohio, Dayton, Cincinnati, Louisville, Ky., Indianapolis, Ind., Terre Haute, St. Louis, Mo., Springfield, Ill., Chicago, Kalamazoo, Mich., Battle Creek, Detroit, Toledo, Ohio, Cleveland, Akron, Youngstown, Erie, Pa., Buffalo, N. Y., Rochester, Syracuse, Utica, Schenectady, Albany, Springfield, Mass., Worcester, Boston, Providence, R. I., Hartford, Conn., New Haven and New York City.

In making this tour, the train will travel over the Baltimore & Ohio, Pennsylvania, Big Four, Louisville & Nashville, Illinois Central, Michigan Central, New York Central and the New York, New Haven & Hartford. The tour will end in time for the train to be in position at the World's Fair on April 15, ready for the opening on April 30. A post-exhibition tour is under consideration.

Twenty-Fifth Anniversary of the Railway Educational Bureau

A TESTIMONIAL dinner in celebration of the twenty-fifth anniversary of the Railway Educational Bureau was held on the evening of June 30 at the Union Station in Omaha, Neb., in honor of D. C. Buell, director. The Bureau was founded by E. H. Harriman of the Union Pacific System in 1909 and in 1913 D. C. Buell took over the operation as a private concern and offered the service to all railroad employees in the United States. Among the guests at the dinner were H. R. Safford, senior executive assistant of the Missouri Pacific, Houston, Texas; H. E. Dickinson, general superintendent, Chicago & North Western, Omaha, Neb., and Eugene McAuliffe, president of the Union Pacific Coal Company. The dinner was given and attended by all Bureau employees and their guests. Richard C. Buell, son of the founder of the Bureau, acted as toastmaster. He has been associated with the Bureau for the past four years as special representative and was recently made assistant to the director.

Evening Graduate Course at Stevens Institute

STEVENS Institute of Technology is offering for the first time during the academic year 1938-1939 a program of evening graduate courses. The program supplements the day graduate work which has been given for several years and, in its development, the faculty has considered the needs and interests of graduate engineers employed in the metropolitan area. Co-ordinated groups of related courses are offered in the fields of mechanical engineering, electrical engineering (specializing in communication), and economics of engineering.

With the exception of a few non-credit courses, each course carries credit in one or more approved programs leading to the degree of Master of Science. Although an essential qualification for this degree is graduation from a course in engineering or applied science, admission to graduate courses is open to those otherwise qualified.

Each evening graduate course is scheduled for one two-hour session per week for a semester of fifteen weeks and carries two and one-half credits. Thirty credits are the minimum requirements for the master's degree. Class sessions will ordinarily start at 6:30 p.m. and will be held at the Stevens Institute of Technology, Hoboken, N. J. The first semester will begin during the week of September 26, 1938.

Graduate instruction will be given by members of the Faculty of the institute; by Dr. F. B. Llewellyn of the Bell Telephone Laboratories, Inc., on vacuum tube electronics, and by Dr. David A. Cook of the Western Electric Company, Inc., on industrial psychology.

Inquiries and applications for registration should be addressed to Prof. Frank C. Stockwell, chairman, Committee on Graduate Instruction, Stevens Institute of Technology, Hoboken, N. J.

Employee Representation on the A. C. L.

THE services of the National Mediation Board were recently invoked by the Railway Employes' Department, American Federation of Labor, to settle a dispute as to whether the Brotherhood of Railway Carmen of America, operating through the Railway Employees' Department, A. F. of L., may properly represent carmen, their helpers and apprentices, in the employ of the Atlantic Coast Line.

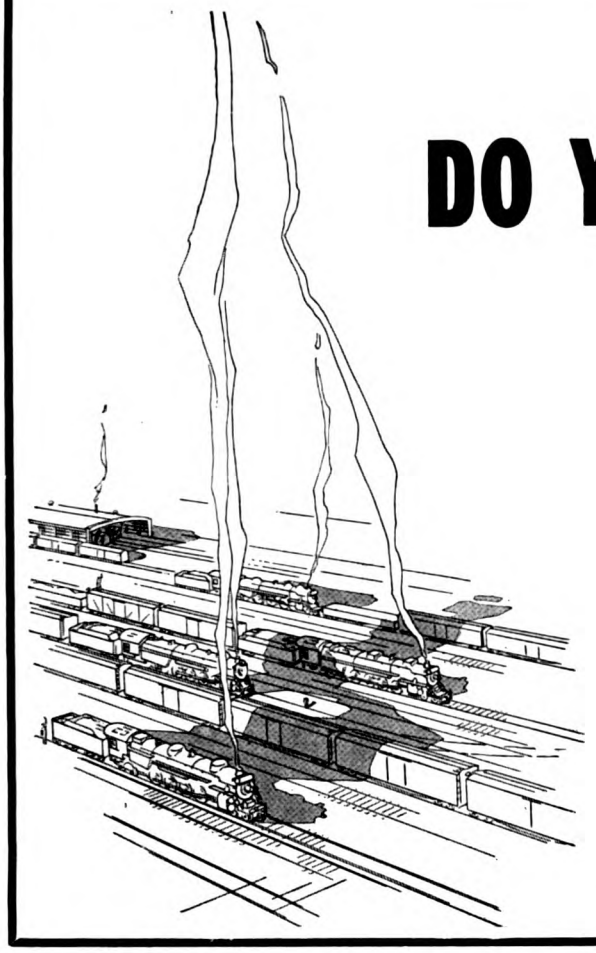
The board assigned Mediator O. F. Carpenter to investigate and, after finding that a dispute existed among the employees in question, directed him to take a secret ballot to determine the choice of the employees, based on an eligible list agreed to by representatives of the contesting organizations. As a result of the election, in which 490 votes were cast for the Brotherhood; 397 for the A. C. L. Shopmen's Association, and four for other organizations or an individual, the National Mediation Board duly designated and authorized the Brotherhood of Railway Carmen of America, operating through the Railway Employees' Department, American Federation of Labor, to represent the craft or class of carmen, their helpers and apprentices, employees of the Atlantic Coast Line, for the purposes of the Railway Labor Act.

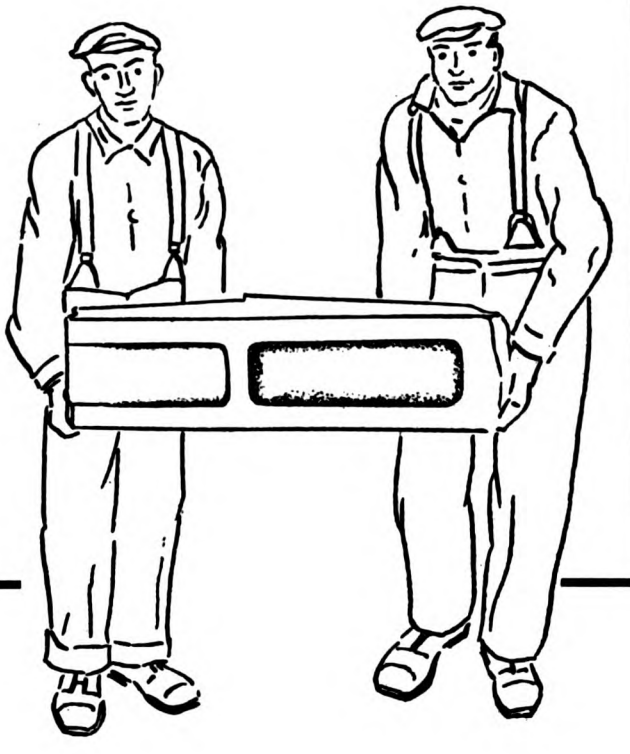
Reading Issues Large Posters of Equipment Photographs

BETTER to comply with numerous requests received each year for photographs of old railroad rolling stock and for picture series portraying the evolution of railroad transportation, the Reading has prepared a stock of large 22-in. by 28-in. white posters containing reprints of 23 photographs of prototypes of the various stages in a three-century march of transport and entitled "Progress in Transportation; 1638-1938." The earlier stages are brought out by old prints and paintings of sailing ships, horse caravans, canal packets and "Conestoga" freight wagons, while steam railroad development is illustrated by early Philadelphia, Pa., locomotives and interesting locomotive types operated by the Reading since its inception. Among the latter are included cuts of one of the early "camel-backs" and a high-speed "Atlantic" type of the class which hauled the early Atlantic City (N.

(Continued on next left hand page)

DO YOU REMEMBER?





Remember years ago when Arch Brick came in slabs that took two men to carry? American Arch Company developed the sectional brick that replaced the old form. » » » Remember years ago when Arch Brick was an uncertain gamble, some was good and a lot was not? American Arch Company made an intensive study of combustion conditions and their relation to Arch Brick composition and took the guess out of Arch Brick. » » » Remember years ago when you ran out of needed shapes and sizes and yet found the storeroom full of Arch Brick? American Arch Company organized a service of supply that corrected such conditions and assured you plenty of Arch Brick when and where needed, without permitting the accumulation of obsolete stock. » » » In the 28 years American Arch Co. has been serving the railroads, it has removed Arch Brick from the list of things to worry about.

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

J.)-Camden "Sixty-Minute Expresses." Included also are photographs of present-day Reading equipment such as the streamline, stainless steel "Crusader," electric multiple-unit cars in Philadelphia suburban service, and a motor coach and freight truck of the Reading Central Transportation Company. A caption underlies each cut which explains in simple fashion the significance of the equipment illustrated and its place in the transportation set-up.

Welding of L- and T-Type Side Frames Prohibited

Upon instructions from the General Committee of the A. A. R. Mechanical Division, recommendations from the Arbitration Committee, concurred in by the Committee on Car Construction, to modify Interchange Rule 23 to prohibit welding of any description on L- and T-type side frames, also that Rules 3 and 19 should be modified to prohibit the application of L- and T-type side frames which have been welded to all interchange cars, were ordered submitted to letter ballot.

The vote on these recommendations was divided into three propositions which, as a result of favorable letter ballot, are now approved, effective January 1, 1939, and will be incorporated in the next supplement to the current Code of Interchange Rules as advance information.

Supply Trade Notes

THE AMERICAN BRAKE SHOE & FOUNDRY COMPANY of California has changed its name to The American Brake Shoe & Foundry Company, Pacific Coast Division.

◆

J. C. BLOOMFIELD, formerly western sales manager of the Link Belt Company, Chicago, has entered the railway supply business with offices at Room 608 McCormick Bldg., Chicago.

◆

S. L. POORMAN, assistant manager, at New York, of the Westinghouse Air Brake Company, has been promoted to eastern manager, with headquarters as formerly at New York. Mr. Poorman's engineering and commercial experience has extended over a period of 25 years, during which time he has served as test engineer,



S. L. Poorman

mechanical expert, representative and assistant manager. He has participated in the activities that have to do with the application of air brakes to all forms of railway transportation.

◆

J. B. TATE, for over 30 years in the operating and purchasing departments of the Pressed Steel Car Company, has been appointed general manager of the H. K. Porter Company, Pittsburgh, Pa.

◆

WILLIAM A. ROSS and A. L. Berlin of the sales department of the Pyle-National Company, Chicago, have been appointed sales manager and assistant sales manager, respectively, with headquarters at the general offices and factory of the company at 1334 North Kostner avenue, Chicago.

◆

THAYER B. FARRINGTON has opened an office as consulting engineer at 308 Euclid avenue, Cleveland, Ohio. Mr. Farrington



T. B. Farrington

previously served as assistant works manager of the Pennsylvania at Altoona, Pa., and later was assistant general superintendent of motive power, with headquarters at Chicago. He then joined the B. F. Goodrich Company at Akron, Ohio.

◆

WILLIAM J. DALY, Detroit district sales manager of the Worthington Pump and Machinery Corporation, Harrison, N. J., has been transferred to the Philadelphia office, to succeed C. H. Shaw, deceased. He will be assisted by W. J. Van Vleck, recently appointed assistant manager in the Philadelphia district.

◆

H. C. DUGGAN has been placed in charge of sales and service of the Detroit Division of Oakite Products, Inc., New York, handling the work of J. A. Maguire, Detroit division manager, who is ill. Mr. Duggan's headquarters are in the General Motors building, Detroit. The New York and New England divisions of the company have also been consolidated into one unit, to be known hereafter as the Northeastern division. D. X. Clarin, New York division manager at New York, is in charge of the new division.

WILLIAM C. SIMPSON has been appointed manager of sales of the newly opened sales office of the Lukens Steel Company in the Gulf building, Pittsburgh, Pa. Mr. Simpson was born at Columbia, N. J. After graduating from the Belvidere, N. J., high school, he attended Blair Academy and Lehigh University, receiving the degree of bachelor of science in metallurgical engineering from the latter in 1932. Early in 1933 Mr. Simpson entered the employ of the Bethlehem Steel Company at Sparrows Point, Md. Since January, 1934, he has served the Lukens organization as research



W. C. Simpson

engineer in the metallurgical department, research metallurgist in the research department, and, since September, 1936, has been in the sales and sales development department.

◆

Obituary

J. ALEXANDER BROWN, vice-president and manager of the Railway Equipment and Publication Company, publishers of The Pocket List of Railroad Officials, Official Railway Equipment Register and Railway Line Clearances, died at Caldwell, N. J., on July 10. Mr. Brown was born in New York City on May 4, 1854. He first entered the publishing field with Poor's Publishing Company. He was manager of the Pocket List of Railroad Officials since that publication was established in 1895, and in 1909 was elected vice-president of the company which office he also held until

(*Continued on next left hand page*)

Always Ahead With the Best

For more than twenty-five years The Superheater Company has designed, manufactured and tested superheater units of every conceivable shape; and has used every conceivable method of fabrication. The Elesco machine-forged unit is the last word.

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Superheaters « Feed Water Heaters « American Throttles
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the time of his death. In 1905 Mr. Brown served as secretary and director of exhibits of the American Railway Appliance Ex-



J. Alexander Brown

hibition held in Washington, D. C., in connection with the International Railway Congress, and the U. S. Government appointed him a delegate to the International Railway Congress held in Berne, Switzerland, in 1910. Mr. Brown was one of the founders of the Railway Supply Manufacturers' Association and for many years served as one of the directors of that association.

F. A. LORENZ, JR., vice-president of the American Steel Foundries, Chicago, died in that city on July 23, after a long illness. Mr. Lorenz graduated from the University of Chicago in 1905 and received his master's degree in engineering from the University of Illinois in 1909. In the same year he entered the service of the Chicago & North Western as a special motive power apprentice at its Chicago shops. During 1910 and 1911 he was employed in various capacities by the Republic Iron and Steel Company at its East Chicago, Ind., plant. In the latter year he entered the employ of the American Steel Foundries as a wheel engineer and later became manager of sales of Davis wheels, assistant to the fourth vice-president in charge of operations and works manager of the Indiana Harbor works. In 1930 he was promoted to general manager of the Indiana Harbor and Pittsburgh works, in charge of sales and production. He was elected vice-president in 1934.

◆

OLIVER MURRAY EDWARDS, SR., founder and chairman of the board of The O. M. Edwards Company, Inc., Syracuse, N. Y., died suddenly from a heart attack at his summer home, Eagle Bay on Fourth Lake, Adirondack Mountains, N. Y., on July 2. Mr. Edwards was born at Ephrath, Fulton county, N. Y., on October 20, 1862. He attended elementary and intermediate schools in Johnstown, N. Y., and Johnstown Academy, and was graduated from the Boys' Academy, Albany, N. Y. Mr. Edwards' death ended a business career that began more than 50 years ago when, as a youth, just out of school, he first revealed an inventive ability which was the foundation of the railroad and office equipment manufacturing business that bore his name. One of his earliest devices was a



Oliver Murray Edwards, Sr.

design for window fixtures for railway cars which is still employed by the railroads. Another invention was an extension platform trapdoor which became standard railroad equipment. Other railroad devices followed.

Personal Mention

General

JOSE MARTINEZ CAMPOS has been appointed superintendent of motive power and machinery of the National Railways of Mexico, succeeding Aquiles Amparan, who has resigned.

S. E. MUELLER, superintendent of shops of the Chicago, Rock Island & Pacific at Silvis, Ill., has been appointed superintendent of motive power, second mechanical district, with headquarters at Kansas City, Mo., to succeed J. M. Kerwin.

WALTER ALEXANDER, master mechanic on the Canadian National at Winnipeg, Man., has been promoted to superintendent of motive power and car equipment of the Alberta district with headquarters at Edmonton, Alta., succeeding W. Walker.

W. WALKER, superintendent of motive power and car equipment of the Canadian National at Edmonton, Alta., has been transferred to the Manitoba district, with headquarters at Winnipeg, Man., succeeding H. A. English, retired.

A. R. RUITER, master mechanic on the Chicago, Rock Island & Pacific at Kansas City, Kan., has been appointed assistant chief operating officer, mechanical, a newly created position, with headquarters at Chicago.

C. S. PERRY, master mechanic of the Atlanta, Birmingham & Coast at Fitzgerald, Ga., has been appointed superintendent motive power, with headquarters at Atlanta, Ga., succeeding A. W. Kirkland.

A. W. KIRKLAND, superintendent motive power of the Atlanta, Birmingham & Coast at Atlanta, Ga., has retired.

Master Mechanics and Road Foremen

S. E. FULKS has been appointed road foreman of engines, Handley coal subdivision, of the Chesapeake & Ohio, with headquarters at Handley, W. Va.

M. K. ROBB has been appointed master mechanic of the Canadian National at Prince Albert, Sask., relieving P. J. Sproule.

P. J. SPROULE, master mechanic of the Canadian National at Prince Albert, Sask., has been transferred to Sioux Lookout, Ont., to succeed C. D. Smith.

G. W. HEYMAN, master mechanic of the Chicago, Rock Island & Pacific at Cedar Rapids, Iowa, has been transferred to Kansas City, Kan., replacing A. R. Ruiter.

A. W. BYRON, master mechanic of the Philadelphia Terminal division of the Pennsylvania, has been appointed master mechanic of the Philadelphia Terminal, Atlantic divisions, and the Pennsylvania-Reading Seashore Lines.

H. C. MCCULLOUGH, road foreman of equipment of the Chicago, Rock Island & Pacific at Kansas City, Mo., has been promoted to master mechanic at Cedar Rapids, Iowa, relieving G. W. Heyman.

J. M. KERWIN, superintendent of motive power second district of the Chicago, Rock Island & Pacific at Kansas City, Mo., has been appointed master mechanic at Shawnee, Okla., replacing L. D. Richards.

C. D. SMITH, master mechanic of the Port Arthur division of the Canadian National at Sioux Lookout, Ont., has been transferred to Winnipeg, Man., succeeding W. Alexander.

FRANK K. MOSES, master mechanic of the Baltimore & Ohio Chicago Terminal at Chicago, has retired. Mr. Moses entered the service of the B. & O. in May, 1889, as an engine wiper, at Garrett, Ind. In February, 1890, he became a machinist apprentice, and in February, 1894, machinist. He left the B. & O. in April, 1902, to enter business, returning to the B. & O. as a machinist in October, 1905. In October, 1907, he was promoted to the position of enginehouse foreman. He entered the service of the Clover Leaf Railroad in October, 1908, but again returned to the B. & O. in November, 1910, as drop-pit foreman. He was reappointed enginehouse

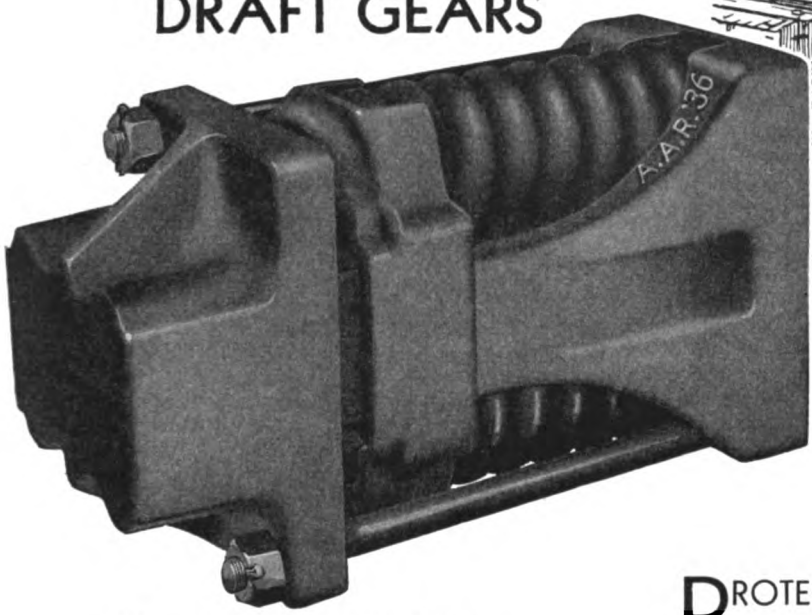
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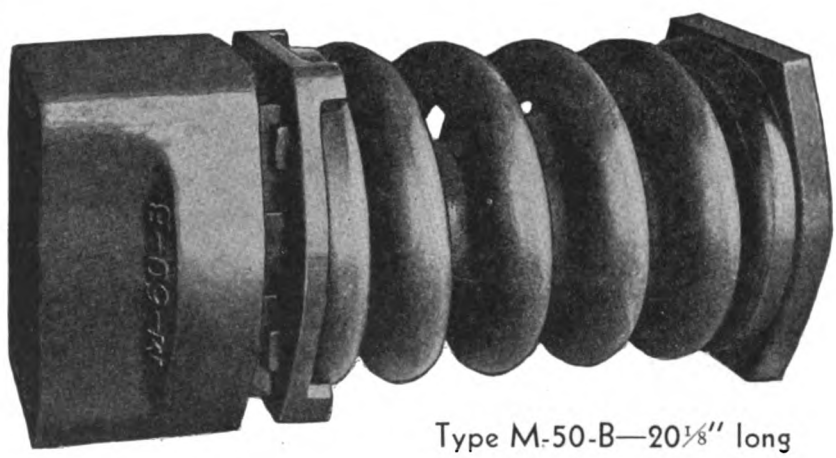
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foreman in December, 1910, and in June, 1913, became general foreman. He was transferred to the B. & O. C. T. as master mechanic in December, 1914.

J. L. MARKS, assistant master mechanic of the Middle division of the Pennsylvania, has been appointed assistant master mechanic of the Philadelphia division, with headquarters at Harrisburg, Pa.

Car Department

W. E. SCRAGG has been appointed division general car foreman of the Boston & Maine, with headquarters at East Deerfield, Mass.

C. ANGUS, car foreman of the Temiskaming & Northern Ontario, with headquarters at Timmins, Ont., has been appointed general car foreman, with jurisdiction over car department matters, with headquarters at North Bay.

Shop and Enginehouse

L. D. RICHARDS, master mechanic of the Chicago, Rock Island & Pacific at Shawnee, Okla., has been appointed superintendent of shops at Silvis, Ill., replacing S. E. Mueller.

Purchasing and Stores

GEORGE A. STINCHFIELD has been appointed acting storekeeper of the Maine Central and the Portland Terminal, with headquarters at Waterville, Me., succeeding H. P. Richardson, deceased.

C. S. PALSGROVE, district storekeeper of the Chicago & North Western, with headquarters at Clinton, Iowa, has been transferred to Boone, Iowa, with the same jurisdiction as formerly.

THOMAS P. HARRIS, assistant purchasing agent of the Canadian National at Montreal, has been appointed purchasing agent of the Grand Trunk Western at Detroit, Mich., to succeed W. E. Evans. Mr. Harris was born in Bristol, England, on



T. P. Harris

October 26, 1896, and entered the service of the Grand Trunk in July, 1911. He left in February, 1915, to enlist in the Canadian Expeditionary Force and on demobilization in May, 1919, returned to the purchasing department.

Obituary

M. A. KINNEY, general master mechanic of the Chesapeake & Ohio, with headquarters at Columbus, Ohio, died on July 16.

HAROLD P. RICHARDSON, storekeeper of the Maine Central, with headquarters at Waterville, Me., died on June 30, at Elm City Hospital, Waterville, following a short illness.

M. R. FEELEY, master mechanic of the Delaware, Lackawanna & Western at Scranton, Pa., died on July 19. Mr. Feeley entered railroad service with the Lackawanna in 1904 as a machinist apprentice at the Kingsland, N. J. shops. He completed his apprenticeship in 1908, and was appointed assistant foreman shortly afterward. In March, 1912, he was appointed engine foreman at Secaucus, N. J., and in the following December became general foreman at Kingsland shops. Mr. Feeley was advanced to general enginehouse foreman at Hoboken in December, 1916, and seven years later was appointed master mechanic at Scranton.

WILLIAM HALL, formerly general machine shop foreman of the Chicago & Northern and for many years secretary-treasurer of the International Railway General Foremen's Association, passed



William Hall

away at his home in Winona, Minn., June 20, at the age of 81 years. Mr. Hall was born July 12, 1856, in Bromsgrove, England, and came to the United States in 1880. He had been an employee of the Chicago & North Western for 42 years, retiring from active service in 1922. He served as general machine shop foreman at Escanaba, Mich., in 1912, and as erecting shop foreman at Winona, Minn., from 1914 until the date of his retirement.

Mr. Hall was one of the organizers and a charter member of the International Railway General Foremen's Association and served as secretary-treasurer from 1906 to 1937, or almost during the entire existence of the association. He was interested in school affairs and served as a member of the Winona Board of Education for 12 years, being president of the board for three terms.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description

COUNTERBORING TOOLS.—National Twist Drill & Tool Company, Detroit, Mich. 15-page illustrated bulletin. Heavy-duty counterboring tools with patented spline-taper drive.

◆

SAFETY DEVICES.—Willson Products, Inc., Reading, Pa. Catalog illustrates and describes Willson line of eye, nose, throat and lung protectors—goggles, welding handshields and helmets, respirators, etc.

◆

METAL BENDINGS.—Wallace Supplies Mfg. Co., 1310-12 Diversey Parkway, Chicago. Bulletin No. 29. Describes hydraulic, motor-driven and hand-operated bending machines.

◆

TRACTORS; TRUCKS.—Baker Industrial Truck Division of The Baker-Raulang Co., 2168 West Twenty-fifth street, Cleveland, Ohio. General Catalog No. 50; 18 pages, illustrated. General specifications for elevating trucks, Hy-lift trucks, fork trucks, tractors, cranes, etc.

◆

VALVES.—Gold Car Heating & Lighting Co., 220-36th street, Brooklyn, N. Y., Bulletin No. 10; 8 pages. Introduces new pressure reducing and regulating valves, starting valves, and end train pipe valves in the larger sizes for railway, marine and industrial service.

◆

GLOBE AND ANGLE VALVES.—Crane Co., 836 South Michigan avenue, Chicago. "The Inside Story of Crane Plug Disc, Globe and Angle Valves," for throttling, blow-off, boiler feed, or other service where valves are operated in any but a full open or closed position.

◆

"HOW TO RUN A LATHE".—South Bend Lathe Works, South Bend, Ind., 34th edition; 128 pages. Price, 25 cents. Material divided into chapters and subheadings according to machining operations, beginning with the elementary work and progressing to the more advanced metal-working jobs. Illustrates lathe set-ups and methods for handling important machining operations. General shop information.

◆

KOPPERS YEARBOOK, 1938.—Koppers Company, Pittsburgh, Pa. Contains corporation chart and property map and tells for the first time the story of the Koppers Company. Describes how the balance sheet and profit and loss statement of one large American corporation would look if employees had divided the business and each had operated as a one-man concern, and the position of the Koppers Company as a shipper.

RAILWAY MECHANICAL ENGINEER

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.

September, 1938

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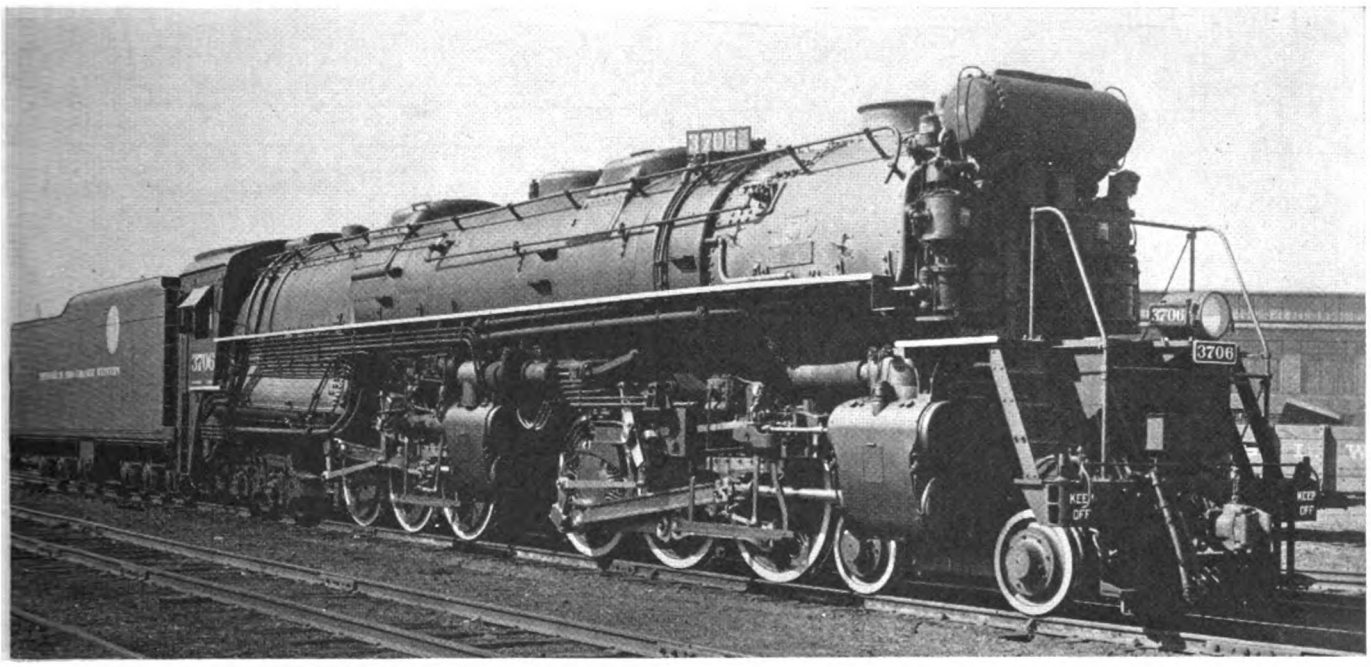
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Ten 4-6-6-4 Single Expansion, Articulated

D. & R. G. W. Locomotives



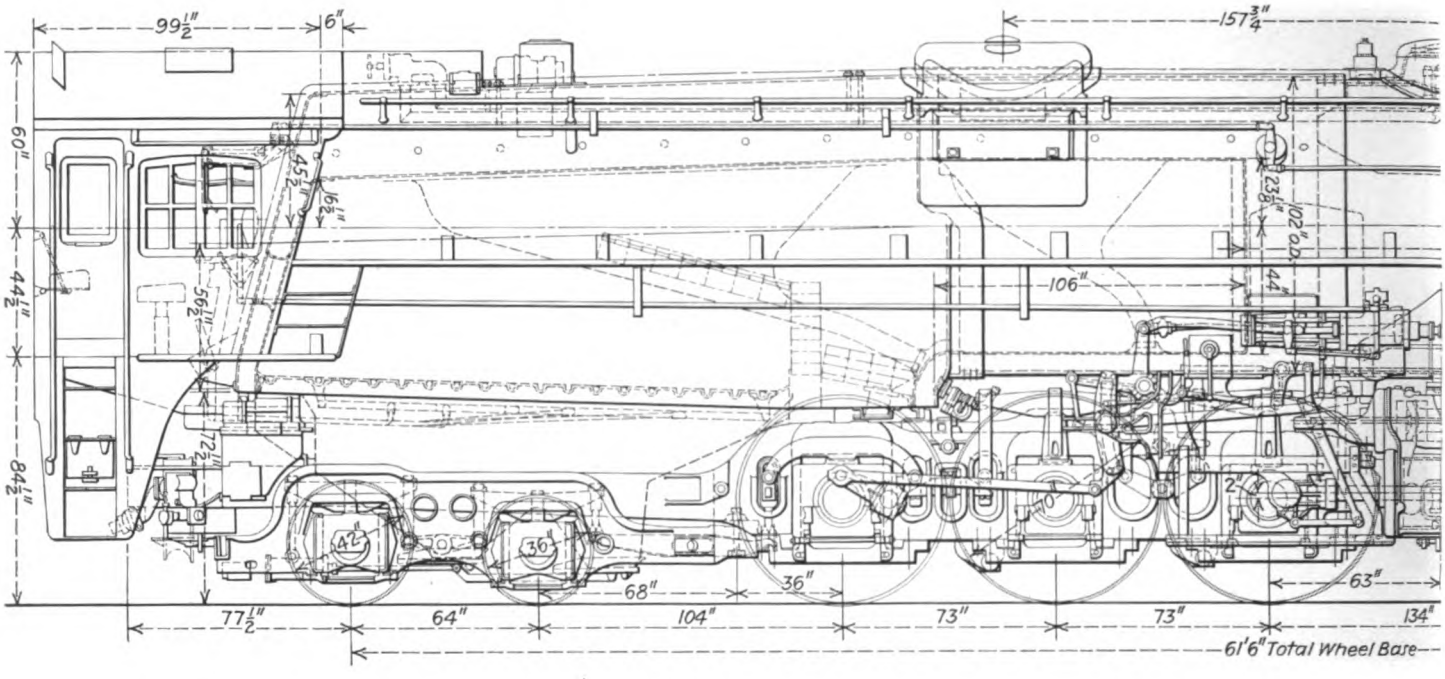
New motive power for fast-freight service is first of its type on that road — Design is featured by large boiler, 70-in. diameter drivers and 105,000-lb. tractive force

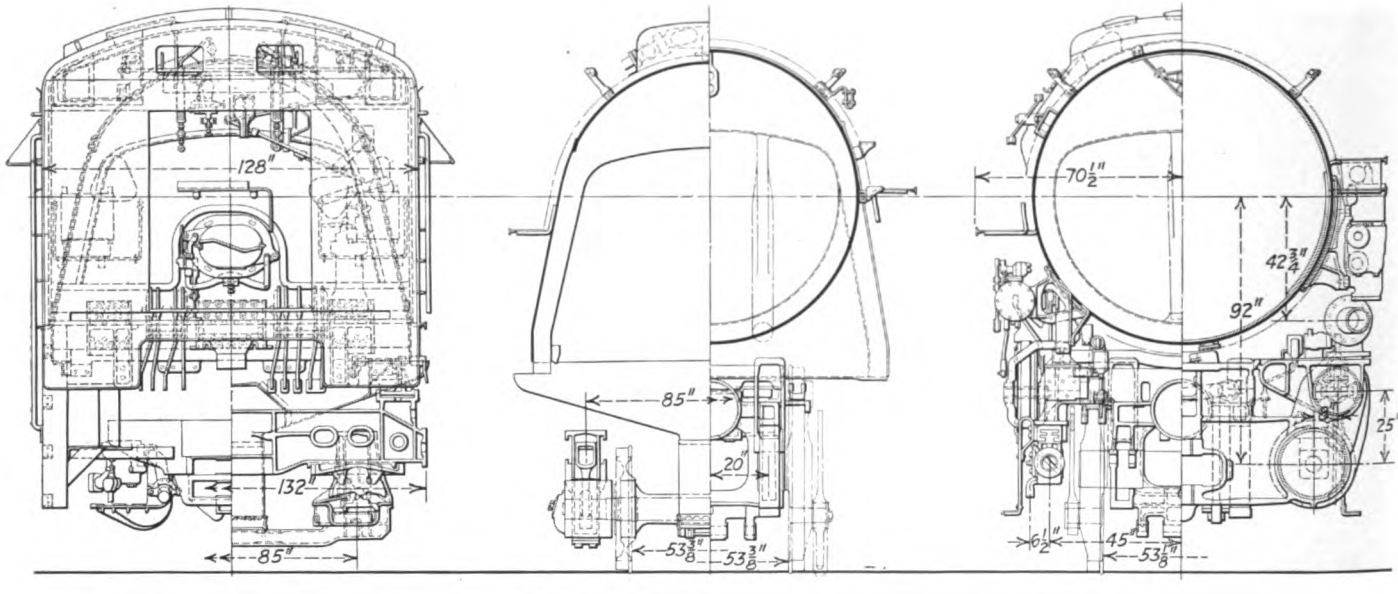
RECENTLY the Baldwin Locomotive Works completed, at its Eddystone, Pa. plant, ten single-expansion, articulated, 4-6-6-4 type locomotives for the Denver & Rio Grande Western which are designed for fast-freight service. These locomotives are now operating between Grand Junction, Colo. and Salt Lake City, Utah, a distance of 295 miles and also between Grand Junction and Minturn, Colo., a distance of 148 miles. In the Grand Junction-Salt Lake City territory the line rises to a maximum elevation of 7,440 ft. above sea level and maximum grades of 2.40 per cent are encountered westbound and 2.0 per cent eastbound. The rating for these locomotives on the westbound run is 2,750 adjusted tons and average speeds of 32 to 34 m. p. h. are maintained except over the ruling grade of 2.40 per cent where helpers are used. On the eastbound run the same tonnage is handled at 38 m. p. h. except over 29 miles of 2.0 per cent grade where helpers are used. In the Grand Junction-Minturn territory the maximum elevation reached is 3,242 ft., with 1.42 per cent grades and 12-deg. curves.

The locomotives are designed for service on grades up to three per cent and operating curves of 16 deg. The design, however, is laid out for a 22-deg. curve. In spite of their size these locomotives have a rigid wheel base of only 12 ft. 2 in., thereby providing greater flexibility than many smaller units. The driving-wheel diameter is 70 in. and the rated tractive force in 105,000 lb.

The Boiler

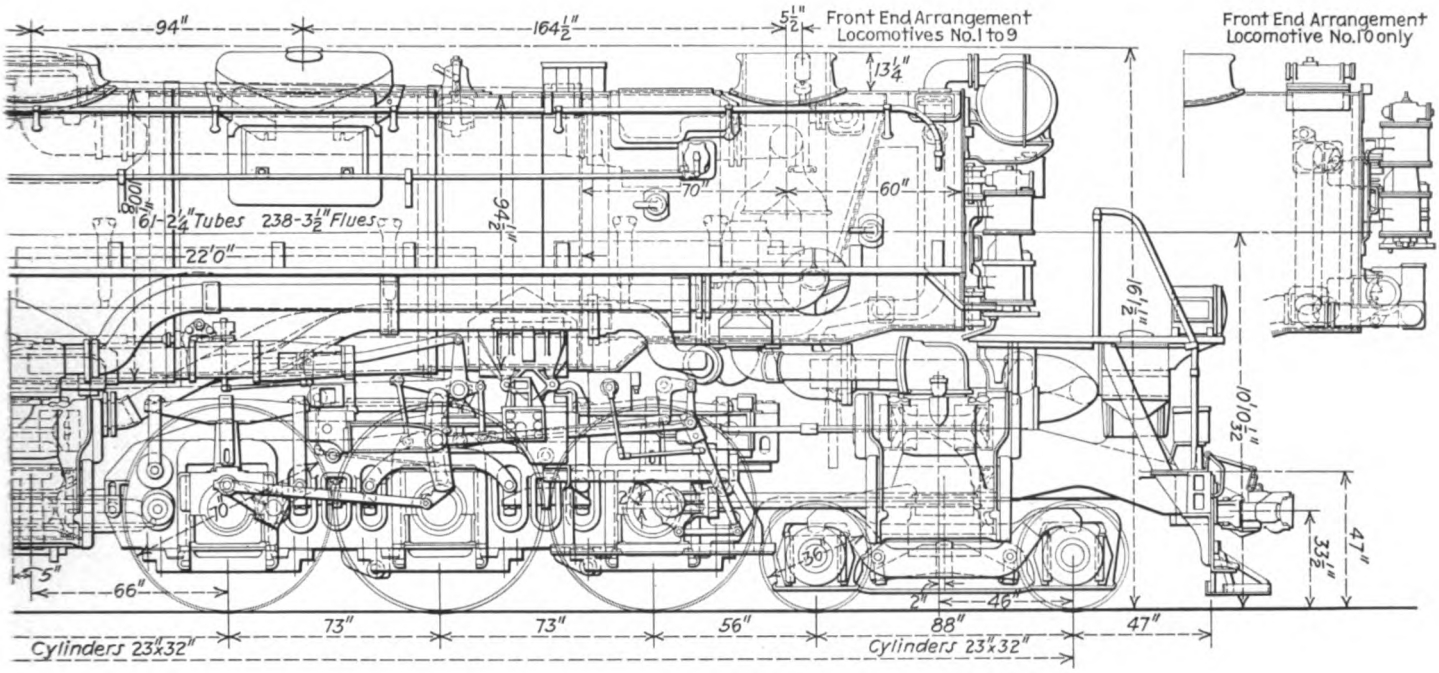
The boilers on these locomotives are of especial interest because of their size, having an overall length of 61 ft. 6½ in. They are designed to burn coal and have a straight-top taper-bottom barrel of four courses, including the combustion-chamber course. The steam dome is located on the course ahead of the combustion chamber. The outside diameter of the first ring behind

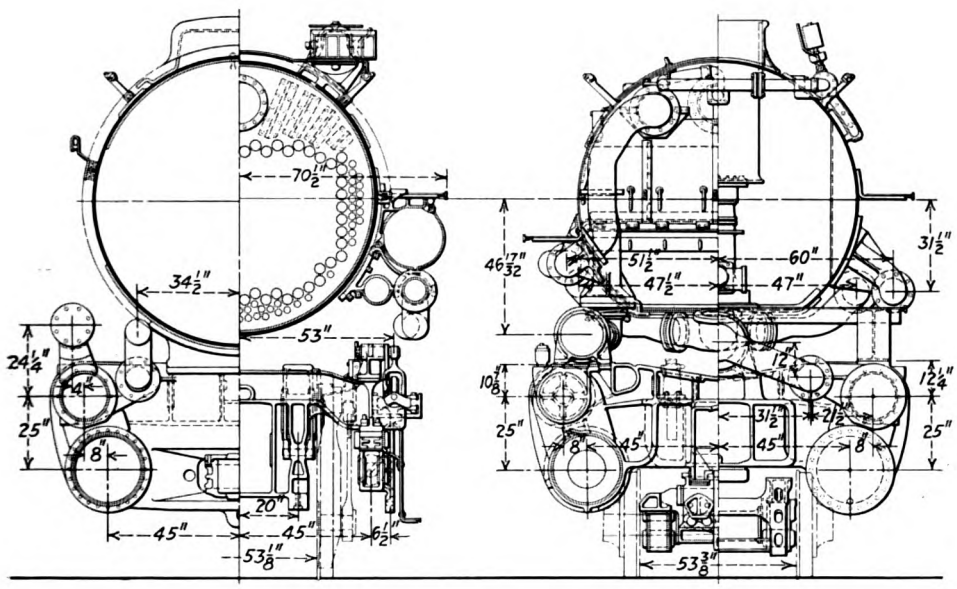




General Dimensions, Weights and Proportions of the Denver & Rio Grande Western 4-6-6-4 Type Locomotives

Railroad	D. & R. G. W.
Builder	Baldwin
Type of locomotive	4-6-6-4
Road class	L-105
Road numbers	3700-3709
Date built	April, 1938
Service	Freight
Dimensions:	
Height, max., in.	193½
Height to center of boiler, in.	130 1/32
Width overall, in.	141
Cylinder centers, in.	90
Weights in working order, lb.:	
On drivers	437,939
On front truck	84,550
On trailing truck	119,411
Total engine	641,900
Tender	394,000
Wheel bases, ft. and in.:	
Driving	35—6
Rigid	12—2
Engine, total	61—6
Engine and tender, total	108—0
Wheels, diameter outside tires, in.:	
Driving	70
Front truck	36
Trailing truck, front	36
Trailing truck, back	42
Engine:	
Cylinders, number, diameter and stroke, in.	4—23 x 32
Valve gear, type	Walschaert
Valves, piston type, size, in.	14
Maximum travel, in.	7¼
Steam lap, in.	1⅜
Lead, in.	{ ⅜ at 25 per cent; 0 at full cut-off
Max. cut-off, per cent	86.2
Boiler:	
Type	Wagon bottom
Steam pressure, lb. per sq. in.	255
Diameter, first ring, inside, in.	92¾
Diameter, largest, outside, in.	102
Firebox, length, in.	224¼
Firebox, width, in.	108¼
Height mud ring to crown sheet, back, in.	73
Height mud ring to crown sheet, front, in.	85¼
Combustion chamber length, in.	109½
Thermic syphons, number	3
Tubes, number and diameter, in.	61—2¼
Flues, number and diameter, in.	238—3½
Length over tube sheets, ft. and in.	22—0
Fuel	Coal
Stoker	Standard Model B
Grate area, sq. ft.	136.5
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	613
Thermic syphons	165
Firebox, total	778
Tubes and flues	5,563
Evaporative, total	6,341
Superheating	2,628
Combined evap. and superheat	8,969
Tender:	
Style	Rectangular
Water capacity, gal.	20,000
Fuel capacity, tons	26
Trucks	6-wheel
Rated tractive force, engine, 85 per cent, lb.	105,000





Erecting elevation and cross sections of the D. & R. G. W. 4-6-6-4 simple articulated locomotive

Weight proportions:	
Weight on drivers ÷ weight engine, per cent	68.3
Weight on drivers ÷ tractive force	4.17
Weight of engine ÷ evaporative heat. surface	101.2
Weight of engine ÷ comb. heat. surface	71.6
Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	8.67
Tube-flue heat. surface, per cent comb. heat. surface	62.4
Superheat. surface, per cent comb. heat. surface	29.3
Firebox heat. surface ÷ grate area	5.70
Tube-flue heat. surface ÷ grate area	40.8
Superheat. surface ÷ grate area	19.3
Comb. heat. surface ÷ grate area	65.7
Evaporative heat. surface ÷ grate area	46.6
Tractive force ÷ grate area	781.0
Tractive force ÷ evaporative heat. surface	16.6
Tractive force ÷ comb. heat. surface	11.7
Tractive force × diameter drivers ÷ comb. heat. surface	819.0

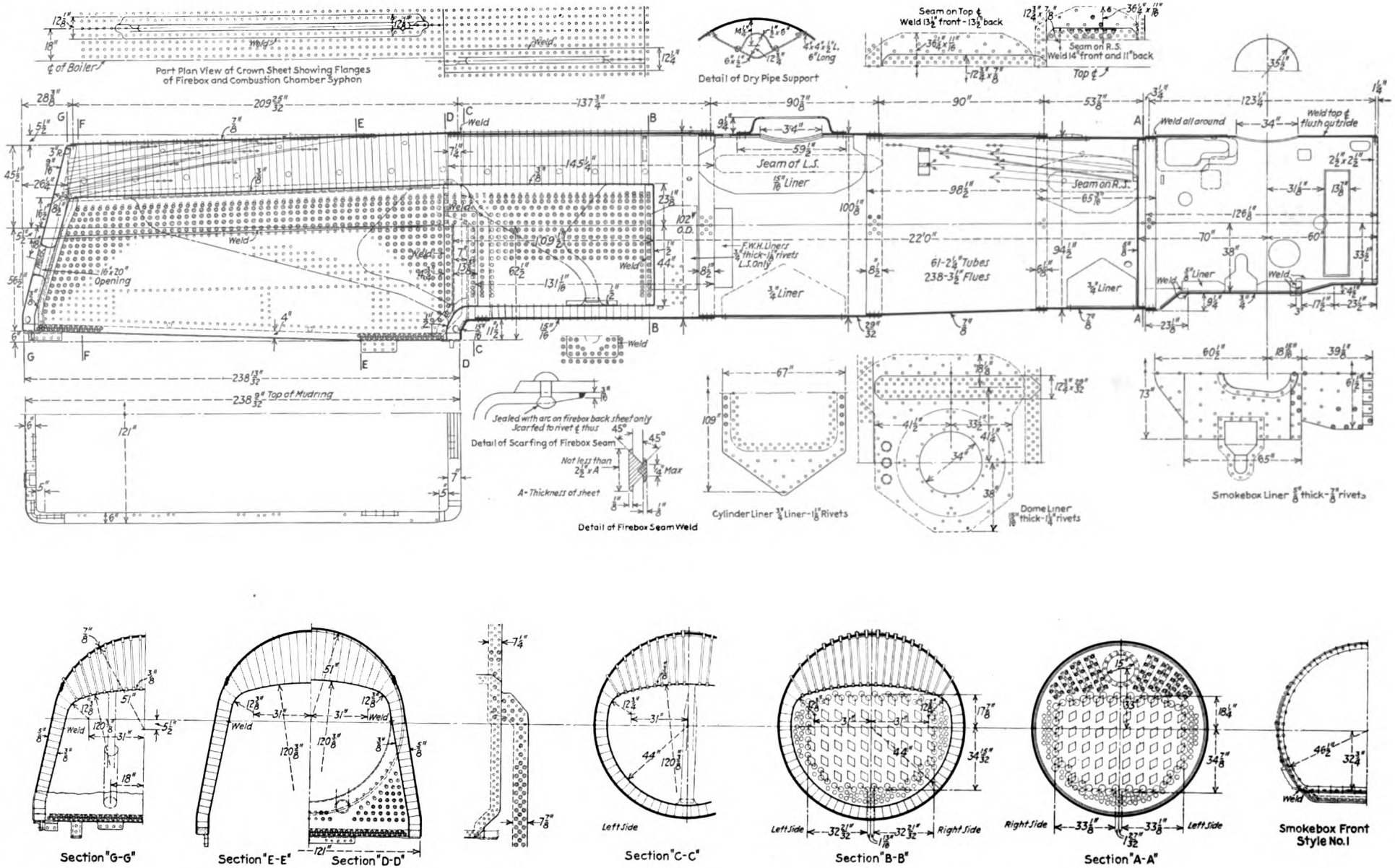
the smokebox is 94½ in. and the outside diameter of the combustion-chamber course is 102 in., the slope in the bottom of the boiler being in the second course in order to provide sufficient water space under the combustion chamber.

The boiler shell is made of silicon-manganese steel, this material also being used for the outside wrapper and outside side sheets, shell liners and welt strips. The horizontal seams are butt joints multiple-riveted with inside and outside welts. The combustion chamber has a height of 67⅛ in. on the center line and is 109½ in. long.

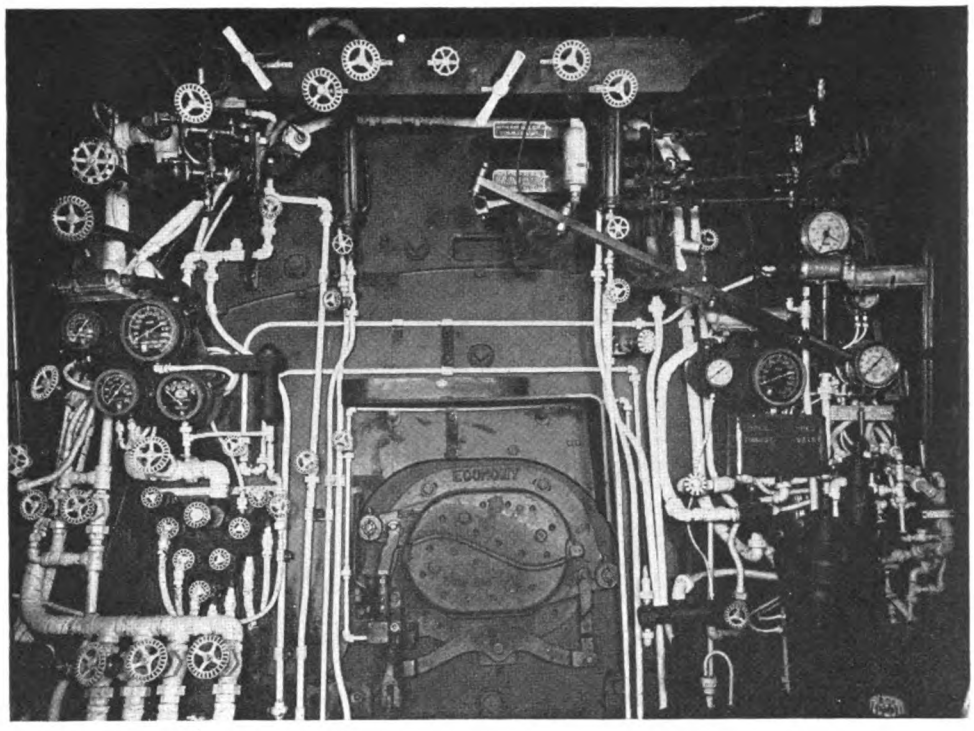
Firebox and Boiler Details

The firebox has a grate area of 136.5 sq. ft. and is 224¼ in. long by 108¼ in. wide. Rosebud (pin-hole) type grates are used. The firebox crown, side and back sheets are ⅜ in. thick and the crown and sides are in three sheets. All of the seams in the inside firebox are electric welded, except the door sheet.

The length of the grates is 182 in. and at the front end of the grate is a transverse fire-brick wall. In front of this wall there is a cinder hopper, in the space between the wall and the front of the firebox. The firebox contains two Thermic syphons which support the brick arch. There is a third Thermic syphon on the center line of the combustion chamber. An extensive application of flexible stays is embodied in the firebox and combustion chamber, this type of staybolt being applied as a complete installation in the throat sheet and combustion



Boiler elevation, cross sections and details



Arrangement of the cab fittings and piping

chamber, in the two outside rows on the back head, and in the breaking zone of the side sheets. Across the front end of the crown sheet there are four rows of expansion stays. The staybolt installation on the firebox and combustion chamber includes 72 expansion stays, 158 radials and 1,923 flexible stays. All flexible sleeves are welded to the sheets.

The grate is divided into three longitudinal sections, with three shaker bars to each section. Coal is distributed to the grates by a Standard modified Type B stoker having seven control valves. The stoker engine is located on the tender. The ash pan is of steel-plate construction and has two large hoppers with air-operated slides.

The boilers are fitted with 61 2¼-in. tubes and 238 3½-in. flues. The length over the tube sheets is 22 ft. Tubes and flues are welded to the back tube sheet.

The boilers are equipped with Type E superheaters with Tangential steam dryers. Saturated steam passes through a 12-in. steel drypipe to the superheater header. The steam flow to the cylinders is controlled by an American multiple type front-end throttle. The boilers are equipped with the Elesco feedwater heater on nine of the locomotives and the Worthington heater on one locomotive. The Elesco heaters are located on the front of the smoke-box, above the air compressors, with the feedwater pump on the left side of the locomotive. In the case of the Worthington heater, it is placed in the top of the smokebox ahead of the stack, with the cold-water pump on the left side close to the tender and the hot-water pump on the smokebox front below the door. Each locomotive is equipped with one Hancock non-lifting, Type K-NL injector of 12,000 gallons capacity. The injector is located on the right side.

Engine Beds and Machinery

Each of the two separate units of these locomotives has its own one-piece bed casting furnished by the General Steel Castings Corporation, in which the cylinders are cast as an integral part. They are fitted with articulated hinge connections equipped with the Cardwell-Westinghouse friction draft gear to permit movement between the units of about 1 in. longitudinally.

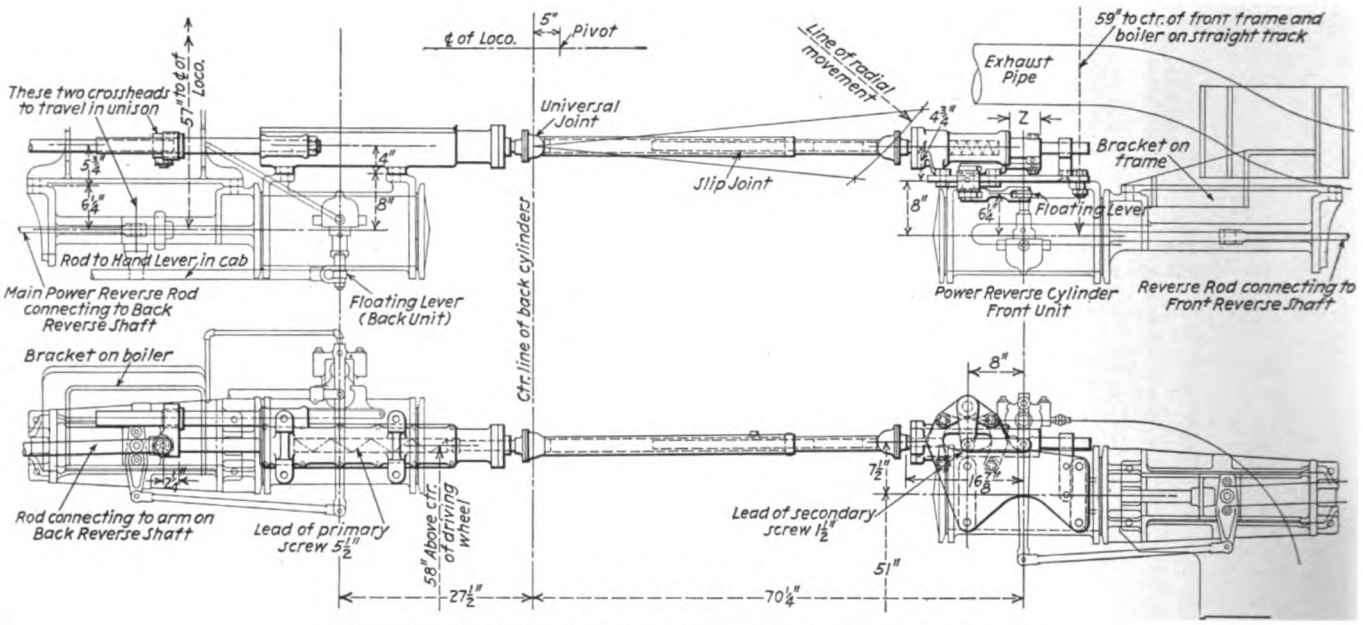
The cylinders, four in number, are 23 in. bore by 32 in. stroke and are 90 in. between centers. The cylinder barrels are strengthened by a continuous rib 1½ in. wide between the front and back stud flanges which also serves as a jacking strip. The steam distribution is effected by a 14-in. piston valve actuated by the Walschaert valve gear. The cylinder and valve bushings and valve packing rings are of Hunt-Spiller gun iron. The cylinder cocks, cylinder drain valves and cylinder-cock operating valves are of Okadee design. The cylinder heads are of cast steel. The piston heads are of nickel cast steel fitted with packing rings of copper-tin bronze. The piston rods are 5 in. in diameter, of carbon steel.

The guides are of the multiple-bearing type with the Alco Slidguide connection to the back cylinder head.

These locomotives are equipped with an arrangement for providing variable lead similar to that applied to a group of 4-8-4 type locomotives* built for the D. & R. G. W. in 1929. The front end of the radius rod is fixed to a block which moves vertically in a slide in the upper end of the combination level. This block is suspended from a bell crank connected to the reverse shaft by a reach rod. The movement of this block effects a change in the length of the combination lever so that the lead may be increased from zero in full gear to ⅜ in. at 25 per cent cut-off. The maximum valve travel is 7¼ in.

The valve gear is controlled by two Baldwin Type C power reverse bears, one for the front unit located on a bracket cast on the bed and another for the rear unit supported on the boiler. Synchronous control of the two valve gears is effected by means of a connection between the reverse shaft on the rear unit and the floating lever of the reverse gear operating the forward valve motion, this action being fitted with two universal joints and one slip joint which permit it to accommodate itself to the swing of the front unit when negotiating curves. By means of this arrangement identical cut-offs on both front and rear units are possible. This arrangement for controlling the valve gears is covered by patent applica-

* Described on page 621 of the October, 1929, issue of the *Railway Mechanical Engineer.*



Arrangement for synchronizing the operation of the two power reverse gears

tion. In order to effect the most economical handling of the Valve Pilot has been applied.

The driving-wheel centers on these locomotives are 63 in. diameter and are the Baldwin cast-steel disc type. The material in the driving-wheel centers is special high-tensile steel. The diameter of the drivers, outside the tires is 70 in. All of the driving-wheel tires are flanged. The driving axles are of hammered carbon steel and are equipped with SKF roller bearings. The total lateral allowed on driving boxes is 3/16 in. Forty per cent of the reciprocating weight is balanced and the main wheels are cross balanced. The main and side rods and crank pins are of carbon steel. The main rods are connected to the third pair of wheels on each unit and all crank pins are fitted with floating bushings.

The front engine truck, furnished by the General Steel Castings Corporation, is designed for a truck swing of 6 in. each side of the center line. The engine-truck axles are fitted with A. S. F. roller-bearing units. The rear truck is of the Delta type and is also fitted with A. S. F. roller-bearing units. It is designed to swing 8½ in. on each side of the center line at the rear wheel. The lateral allowed on the engine-truck-wheel bearings is 3/16 in. total. At the front bearing of the rear truck 3/8 in. total lateral is allowed and at the rear wheels, 1/4 in.

The couplers at the front end of the engine and at the rear of the tender are Type E furnished by the National Malleable and Steel Castings Company. A Franklin friction radial buffer is used between the engine and tender together with the Unit Safety drawbar.

The cab is of the vestibule type, of steel plate with all seams welded; it is lined with wood. Polished plate glass is used throughout the windows. The front and back windows, through which the crew is required to

Partial List of Materials and Equipment on the Denver & Rio Grande Western 4-6-6-4 Type Locomotives

Frames; engine-bed castings; trucks	General Steel Castings Corp., Eddystone, Pa.
Wheels, front truck	Standard Steel Works Co., Burnham, Pa.
Wheels, trailer truck	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Wheel centers, disc type	Standard Steel Works Co., Burnham, Pa.
Tires, driving wheel	American Locomotive Co., New York
Axles, driving and trailer truck	Standard Steel Works Co., Burnham, Pa.
Springs, truck	American Steel Foundries, Chicago
Bearings, driving-wheel	SKF Industries, Philadelphia, Pa.
Bearings, engine and trailer truck	American Steel Foundries, Chicago
Slidguide attachment	American Locomotive Co., New York
Air brake equipment	Westinghouse Air Brake Co., Wilmerding, Pa.
Driver brake	American Brake Co., St. Louis, Mo.
Brake shoes	American Brake Shoe & Foundry Co., New York
Drawbar and radial buffer	Franklin Railway Supply Co., Inc., New York
Coupler	National Malleable and Steel Castings Co., Cleveland, Ohio
Piston rods	Standard Steel Works, Burnham, Pa.
Piston-rod packing	Paxton-Mitchell Co., Omaha, Neb.
Piston-valve packing rings	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Air-pump packing	Johns-Manville Sales Corp., New York
Air-pump lubricator	Westinghouse Air Brake Co., Wilmerding, Pa.
Mechanical lubricators	Detroit Lubricator Co., Detroit, Mich. Ohio Injector Co., Wadsworth, Ohio
Cylinder valves and cocks	The Okadee Company, Chicago
Cylinder and valve bushings	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Crank pins	Standard Steel Works Co., Burnham, Pa.
Crosshead pin lubrications	Alemite Div. Stewart-Warner Corp., Chicago
Valve pilot	Valve Pilot Corporation, New York
Reverse gear	The Baldwin Locomotive Works, Philadelphia, Pa.
Firebox steel	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Lagging	Johns-Manville Sales Corp., New York
Jacket iron	Armco Railroad Sales Co., Middletown, Ohio
Staybolt iron	Joseph T. Ryerson & Son, Inc., Chicago Ewald Iron Co., Louisville, Ky.
Brick arch	American Arch Co., Inc., New York
Tubes	National Tube Co., Pittsburgh, Pa.
Thermic syphons	Locomotive Firebox Co., Chicago
Superheater, Type E, with tangential dryer	The Superheater Company, New York
Throttle	American Throttle Co., New York
Steam-pipe expansion joints	Paxton-Mitchell Co., Omaha, Neb.
Steam-pipe covering	Union Asbestos & Rubber Co., Chicago
Feedwater heater	(9) The Superheater Company, New York (1) Worthington Pump and Machinery Corp., Harrison, N. J.
Injectors; blower valves; safety valves; steam gages	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Blow-off cocks	The Okadee Company, Chicago
Blower connections	Barco Manufacturing Co., Chicago
Steam-heat connections	Vapor Car Heating Co., Inc., Chicago
Air and steam gage holders	Swanson Co., Chicago
Stoker	Standard Stoker Co., Inc., New York
Sanders	Graham-White Sander Corp., Roanoke, Va.
Bell ringer	Railway Service and Supply Corp., Indianapolis, Ind.
Headlights	(5) Pyle-National Co., Chicago (5) Sunbeam Electric Mfg. Co., Evansville, Ind.
Gage lamps	Pyle-National Co., Chicago
Marker lamps	The Adams & Westlake Co., Elkhart, Ind.
Classification lamps	Handlan, Inc., St. Louis, Mo.
Indicator boxes	The Adams & Westlake Co., Elkhart, Ind.
Cab window glass	Libbey-Owens-Ford Glass Co., Toledo, Ohio
Flexible joints between engine and tender	Barco Manufacturing Co., Chicago
Lacquer	E. I. duPont de Nemours & Co., Wilmington, Del.
Tender:	
Underframe and trucks	General Steel Castings Corp., Eddystone, Pa.
Tender-truck wheels and axles	Standard Steel Works Co., Burnham, Pa.
Roller bearings	SKF Industries, Philadelphia, Pa.
Springs	American Steel Foundries, Chicago
Spring-rigging lubrication	Alemite Div. Stewart-Warner Corp., Chicago
Clasp brake; coupler yoke	American Steel Foundries, Chicago
Coupler	National Malleable and Steel Castings Co., Cleveland, Ohio
Draft gear	Cardwell Westinghouse Co., Chicago
Tank bottom	General Steel Castings Corp., Eddystone, Pa.
Hose strainer	The Okadee Company, Chicago



Front end showing feedwater heater and air compressors

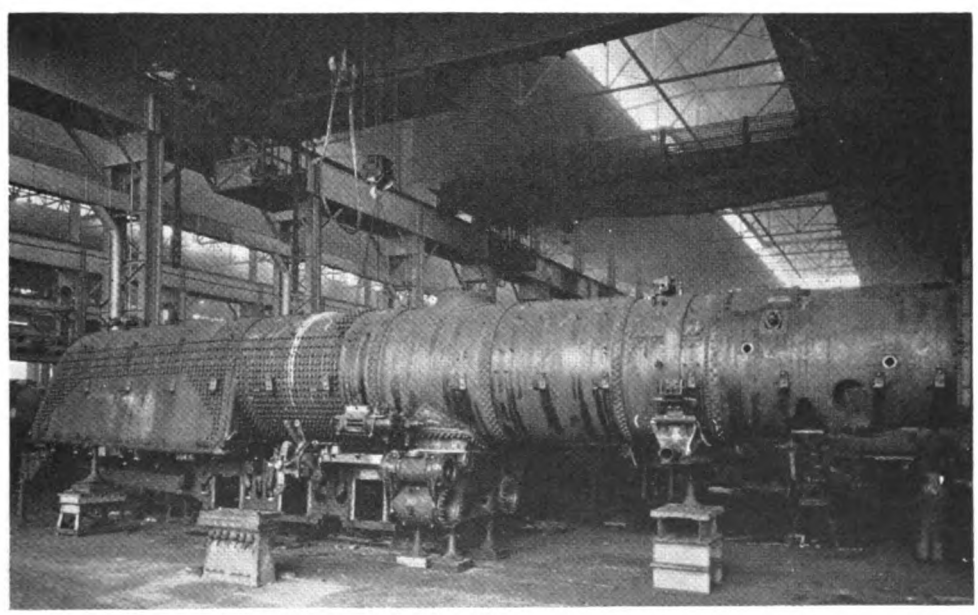
look, are $\frac{3}{16}$ in. thick and the others are $\frac{1}{8}$ in. thick.

The Westinghouse No. 8ET air-brake equipment is used on all driving and tender wheels. The American Brake Company's foundation brake is used on the drivers. Two 8½-in. cross-compound air compressors are mounted on the smokebox front. The main and auxiliary reservoirs, cast in the rear engine bed, have a combined capacity of 29,000 cu. in. and two additional reservoirs under the left running board provide an additional 72,600 cu. in., making a total of 101,600 cu. in. reservoir capacity. The Le Chatelier water brake, used on the D. & R. G. W., is also applied to these locomotives. The headlight equipment on five of the locomotives was furnished by Pyle-National and on the remaining five by Sunbeam. Each engine unit has a sandbox with 20 cu. ft. capacity and the sand is distributed by Graham-White sanders. The locomotives are fitted with air signal and steam-heat equipment so that, if desired, they may be used in passenger-train service. Barco flexible joints are used on the air signal and steam lines between the engine and tender.

Lubrication

Locomotives of this size present an unusual problem in lubrication. On these the lubrication system comprises three types: The self-contained lubrication for the roller-bearing axle boxes on the trucks and drivers; the mechanical lubrication, under pressure, for the major parts of the machinery, and the pressure grease lubrication. The latter consists of the use of the Alemite system on rods, crosshead pins and trailer truck radius-bar seat. The mechanical lubricating system consists of six Detroit Model A lubricators of 30 pints capacity, three for each unit. Two lubricators on each unit are mounted on the left side and one on the right side and all are driven from the valve motion. Through the medium of 40 lubricator feeds, 17 two- and four-way oil dividers and 86 oil lines, the oil is fed to the valves and cylinders, main guides, valve-stem crosshead guides, lead changers, driving- and engine-truck-box pedestals, engine-truck center pin, articulated hinge pins, waist-bearer saddle, ball and expansion joints in steam and exhaust pipes and the radial buffer between the engine and tender. There is also one Chicago K-23 hydrostatic lubricator of three pints capacity in the cab for the feed-water pump and stoker engine, and flange lubricators for the leading drivers of each unit.

The tender is of the rectangular type, having a cast-steel water-bottom frame furnished by the General Steel Castings Corporation and a riveted tank. The water capacity is 20,000 gallons and the coal capacity 26 tons. The General Steel Castings six-wheel tender trucks with cast-steel frames, swing bolsters and top equalizers are used. The tender-truck axles are fitted with SKF roller bearings, The tender-truck brakes are of the clasp type furnished by the American Steel Foundries. The draft gear at the rear end of the tender is Cardwell-Westinghouse type N. Y.-11-E.



The boiler and the rear engine unit assembled in the erecting shop

Fall Meetings of

Mechanical Associations

MEETINGS of three mechanical associations and an executive committee meeting of a fourth will be held at the Hotel Sherman, Chicago, on September 27-28. Full programs of papers and committee reports, as shown below, will be presented by the Car Department Officers' Association, the Railway Fuel and Traveling Engineers' Association, and the Master Boiler Makers' Association.

All members of the Railway Fuel and Traveling Engineers' Association are promised advance copies of the reports ten days in advance of the meeting. The constitution will be up for adoption at this meeting, which is the second annual meeting of the new association.

The program of the Car Department Officers' Association calls for a two-day meeting in four sessions, with a full program of association business, including election of officers, as well as the reports of committees dealing with the subjects and problems of interest to officers and supervisors of the car department.

All members are being invited to attend the open business meeting of the Master Boiler Makers' Association, at which a minimum of association business will be transacted and attention centered on the discussion of the topics pertaining to locomotive boiler operation and boiler shop practice. There will be no election of officers.

A meeting of the officers and members of the executive committee of the International Railway General Foremen's Association will face the problem of the future of the association itself, as well as the proposals that places be made in it for the members and programs of the International Railway Master Blacksmiths' Association and the American Railway Tool Foremen's Association. No papers or committee reports are being presented.

Car Department Officers Association

SEPTEMBER 27

9 a. m.

Approval of minutes of last annual meeting
Remarks by president
Report of Membership Committee
Report of secretary-treasurer
Unfinished business
New business

2 p. m.

Freight and Passenger Car Construction and Maintenance. Chairman, J. McMullen, superintendent car department, Erie

Shop Operation, Facilities and Tools. Chairman, J. A. Deppe, superintendent car department, Chicago, Milwaukee, St. Paul & Pacific

Passenger-Train-Car Terminal Handling. Chairman, G. R. Anderson, district master car builder, Chicago & North Western

Lubricants and Lubrication. Chairman, L. R. Wink, assistant superintendent car department, Chicago & North Western

Freight-Car Inspection and Preparation for Commodity Loading. Chairman, F. G. Moody, master car builder, Northern Pacific

SEPTEMBER 28

9 a. m.

Interchange. Chairman, M. E. Fitzgerald, master car builder, Chicago & Eastern Illinois

Loading Rules. Chairman, C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau

Billing for Car Repairs. Chairman, D. E. Bell, A. A. R. instructor, Canadian National

Painting. Chairman, L. B. Jenson, passenger-car-shop superintendent, Chicago, Milwaukee, St. Paul & Pacific

Publicity. Chairman, E. L. Woodward, western editor, *Railway Mechanical Engineer*

2 p. m.

Report of Nominating Committee
Election of officers

The Railway Fuel and Traveling Engineers' Association

SEPTEMBER 27

(Three sessions—10 a. m., 2 p. m. and 8 p. m., continuing at 9 a. m. on September 28, if necessary)

SPECIAL PAPERS

Avoidable Factors in Locomotive Design Affecting Fuel Consumption, by F. P. Roesch, vice-president, Standard Stoker Co., Inc.

The Relation of the Engineer and Fireman Towards Fuel Economy, by Harley Finberg, engineman, Northern Pacific

The Relation of the Enginehouse Foreman Towards Fuel Economy, by R. K. Thornley, enginehouse foreman, Wabash

What Can the Traveling Engineer, Fuel Supervisor and Road Foreman Do to Further Fuel Conservation?, by G. M. Boh, district road foreman engines, Erie

What May Be Done in Performance Improvement and Economy by Local (that is, Divisional) Train-by-Train Comparison of Ton-Miles Performance?, by R. S. Twogood, assistant engineer, Southern Pacific

COMMITTEE REPORTS

1—Locomotive Firing Practice—Coal. Chairman, W. C. Shove, general road foreman of engines, New York, New Haven & Hartford
  a—The responsibility of the enginehouse foreman
  b—The responsibility of the engineers
  c—The responsibility of road foremen and fuel supervisors

2—Locomotive Firing Practice—Oil. Chairman, R. S. Twogood, assistant engineer, Southern Pacific
  Suggested instructions for firing heavy oils

3—Fuel Records and Statistics. Chairman, E. E. Ramey, fuel engineer, Baltimore & Ohio
  a—Shall fuel records be based on gross ton-miles or on dollars and cents?
  b—How can the supervisor of locomotive performance and fuel conservation further aid in the improvement of railroad operation? What does he need in the way of statistics, man power and any other media to foster interest?

4—Utilization of Locomotives. Chairman, A. A. Raymond, superintendent fuel and locomotive performance, New York Central

5—Air Brakes. Chairman, W. H. Davies, superintendent air brakes, Wabash
  a—The relationship of the No. 8 ET locomotive brake equipment and train handling
  b—Arrangement and handling of high-speed passenger brake equipment

6—New Locomotive Economy Devices. Chairman, A. G. Hoppe, assistant mechanical engineer, Chicago, Milwaukee, St. Paul & Pacific

7—Steam Turbine and Steam Condensing Locomotives. Chairman, L. P. Michael, chief mechanical engineer, Chicago & North Western

8—Adoption of constitution
Election of Officers.

Master Boiler Makers' Association

SEPTEMBER 27

10 a. m.

Address by President William N. Moore
Address and annual report by Secretary-Treasurer Albert F. Stiglmeier
Good of the association

Topic No. 1—What means can or have been suggested to improve circulatory and other conditions in the locomotive boiler to eliminate leaky stays and cracked side sheets? Chairman, C. W. Buffington, general master boiler maker, Chesapeake & Ohio

Topic No. 2—Honeycombing and slagging of flues and tubes, its cause and prevention. Chairman, Myron C. France, general boiler foreman, Chicago, St. Paul, Minneapolis & Omaha

1:30 p. m.

Topic No. 3—Which type of application of waste bearer angles or tees gives the least trouble? Chairman, Edward H. Heidel, general boiler department foreman, Chicago, Milwaukee, St. Paul & Pacific

Topic No. 4—Pitting and corrosion of locomotive boilers and tenders. Chairman, J. F. Becker, general boiler and machinery inspector, Chicago Great Western

Topic No. 5—Prevention of cinder cutting of flues and tubes, firebox sheets, steam pipes, etc. Chairman, Sigurd E. Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford

Topic No. 6—What can be done to overcome the cracking of outside throat sheets? Chairman, M. V. Milton, chief boiler inspector, Canadian National

Topic No. 7—In the application of flexible staybolts to boilers, which method gives the best results: (a) Screw the bolt up to a decided seat in the sleeve, cut to length and head over the bolt on the firebox end; (b) screw the bolt up to a decided seat in the sleeve and then turn back one-quarter turn before cutting to length and heading bolt over on the firebox end? Chairman, Leonard C. Ruber, superintendent of boiler department, Baldwin Locomotive Works

Topic No. 8—Topics for 1939 meeting. Chairman, Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis

Good of the association

Bureau of Mines Investigation on the Intercrystalline

Cracking of Boiler Steel*

By W. C. Schroeder, A. A. Berk† and R. A. O'Brien‡**

Progress report to the A. R. E. A. Subcommittee on Water Service, Fire Protection and Sanitation relates the present status of embrittlement investigation

THE cracking of steel by intercrystalline attack through the action of a boiler water is one of the most dangerous ills in modern boiler operation. The cracking may progress to a considerable depth and greatly damage the metal before it becomes visible on the surface. Under the microscope cracks of appreciable length have been found that are only a few millionths of an inch wide. This difficulty in finding the cracks is coupled to further danger from the very large concentration of stress they may allow. In the laboratory it has been repeatedly found that intercrystalline cracks, invisible to the eye on the surface of the metal and extending into a ¼-in. section only a few thousandths of an inch, will allow complete fracture to occur from a very light blow with a hammer. These cracks, even when shallow, produce such a high stress concentration that any remaining sound metal is incapable of allowing a distribution of stress and therefore an apparently brittle failure occurs. This effect is not dependent on aging of the metal, but is produced by the action of the boiler water under certain definite conditions. This type of damage may be especially important in locomotive boilers since they are unquestionably subjected to more shock or impact stress than stationary boilers. Furthermore, discovery of the cracks is made difficult by the presence of the insulating jacket over the shell courses.

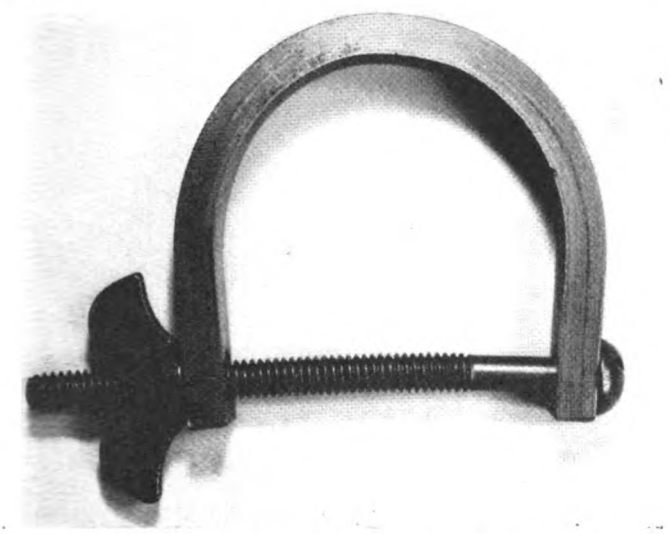


Fig. 1—U-bend specimen ready for immersion in the solution

In 1932 considerable uncertainty still existed concerning adequate methods that might be used to prevent trouble. For example, the boiler code prepared by the American Society of Mechanical Engineers indicated that sodium sulphate would stop cracking. On the other hand, considerable evidence was available to show that this was not always true, especially in locomotive operation.

Cooperative investigation between the Bureau of Mines and the Joint Research Committee on Boiler Feedwater Studies, which received major support from the Associa-

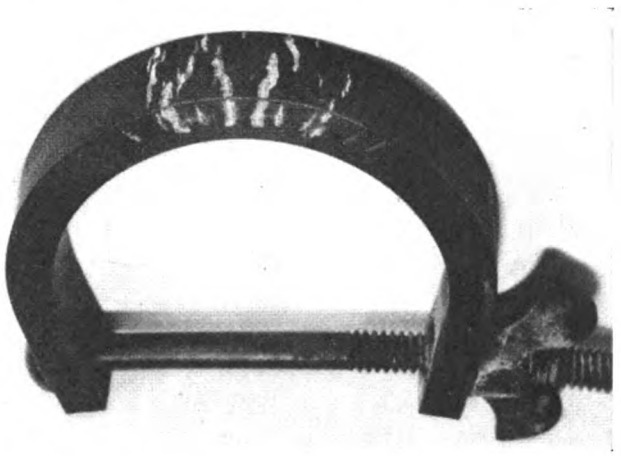


Fig. 2—U-bend specimen of cold-rolled steel broken in sodium hydroxide-sodium nitrate solution

tion of American Railroads, therefore attempted to establish more clearly the solution, concentration and stress factors involved in the production of intercrystalline cracks, and means that could be used to prevent them.

In order to study means for preventing intercrystalline failure it was first necessary to understand how, and under what conditions, it occurred. No investigator has ever been able to produce this type of failure in normal low carbon steel by static stress at room temperature or temperatures in the boiler range; by repeated stresses, or by repeated stresses coupled with corrosion; or by the action of gases such as hydrogen. It has been necessary to have the steel in contact with certain solutions to produce intercrystalline cracking.

Two kinds of specimens were used in the laboratory

* Abstracted from Bulletin No. 404, A.R.E.A., June-July, 1938. The investigation reported in this paper was conducted under a co-operative agreement between the Joint Research Committee on Boiler Feedwater Studies and the Bureau of Mines. The Association of American Railroads is one of the major contributors. The work is carried out at the Bureau's Eastern Experiment Station at College Park, Md. The paper is published by permission of the Director of the Bureau of Mines and is not subject to copyright.

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† Assistant chemist, Bureau of Mines.

‡ Assistant metallurgist, Joint Research Committee on Boiler Feedwater Studies, Bureau of Mines.

to determine the types of solution that would produce intercrystalline or embrittlement failure. The first was a flat strip bent into the form of a U and pulled together by a bolt on the ends. This was largely used in solutions boiling under atmospheric pressure. The second was a tubular specimen closed at one end, that was put under tensile stress by a weight and lever system that will be described later. This specimen was used for tests at pressures from 50 to 1,200 lb. per sq. in.

Action of Solutions in U-Bend Tests

Fig. 1 shows the type of specimen used for the U-bend tests. It consists of a bar of cold rolled steel ¼-in. by ½-in. bent into the shape shown. The ends are pulled together by a bolt to retain a high elastic stress in the metal.

Early investigators believed that cracking could be produced in this specimen by immersion in a concentrated sodium hydroxide, or a concentrated sodium nitrate solution boiling under atmospheric pressure. However, this did not prove to be the case when the specimen was tested for periods up to seven days in pure sodium hydroxide solutions or in periods from three to nine days in pure sodium nitrate solutions.

These early investigators probably secured cracking in their specimens because certain impurities were present in the sodium hydroxide and sodium nitrate they used. For example, Table I shows that a number of oxidizing agents may be added to the hydroxide solutions to cause rapid cracking. The lead oxide (PbO) is especially effective in this respect. Fig. 2 shows one of the specimens cracked in a concentrated sodium hydroxide solution containing a small amount of sodium nitrate. The position of the crack is outlined by the deposit of sodium carbonate resulting from the reaction of the sodium

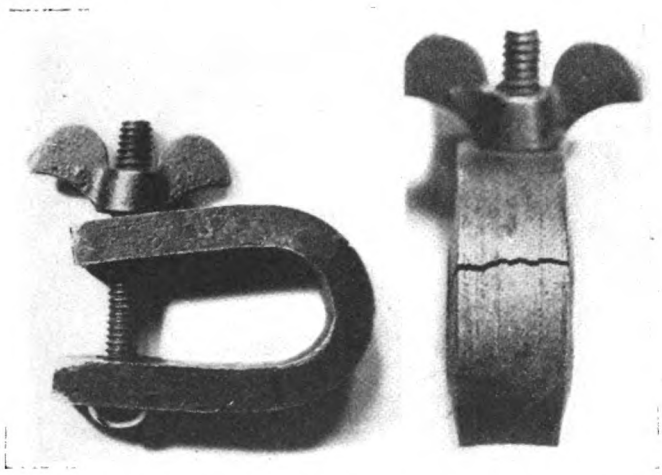


Fig. 3—U-bend specimen of boiler flange steel broken in one day by nitrate-manganese solution

hydroxide as it seeps out of the fissure, with the carbon dioxide of the air. Some of the fine cracks may also be seen. The cracking produced in U-bend specimens by all of the solutions listed in Table I is completely intercrystalline.

It has also been found that the addition of a very small amount of manganous salt will promote the rapid cracking of steel in concentrated sodium nitrate solution. Fig. 3 shows a specimen of boiler flange steel cracked entirely through in one day in a boiling sodium nitrate solution containing a small amount of manganese.

These experiments led to the belief that intercrystalline cracks could be produced in any solution containing both a corrosive and a partially protective agent. To test this theory an attempt was made to produce cracking in a solution containing nitric acid and a manganous salt. Cracking resulted when the proper concentration and temperature conditions were found.

From these experiments with the U-bend specimens, and from many other tests that have already been reported concerning this investigation it has been possible to outline a definite mechanism that can produce this type of failure.

Steel is fundamentally a heterogeneous mass composed of minute grains or crystals. The boundaries between these grains represent material that differs physically or

Table I—Oxidizing Compounds That Will Accelerate Cracking of U-Bend Specimens in Sodium Hydroxide Solutions

Solutions boiling under atmospheric pressure

Grams NaOH per 100 grams water	Oxidizing compound	Grams per 100 grams of water	Crack, days
50	$KMnO_4$	0.2	7
50	Na_2CrO_4	0.2	4-7
50	$NaNO_3$	0.2-1.0	3-5
50	PbO	0.2	1-2

chemically or in both respects from the grains themselves. Ordinary or general corrosion, however, does not attack the grain boundaries preferentially.

If the general corrosion is retarded by an only partially protective film produced by the solution, it is pos-



Fig. 4—U-bend specimen cracked without applied stress

sible to confine the attack largely to the grain boundaries. For example, the oxidizing agents listed in Table I may serve to form a protective film over the crystal or grain faces, leaving the grain boundaries relatively unprotected or exposed to the attack by the sodium hydroxide solution. If the grain boundary is highly stressed, this localized chemical attack will cut the boundary just as a sharp knife cuts a bowstring. The widening of the notch by the stress will prevent the accumulation of corrosion products from stopping further attack. Once this notch is deep enough the corrosion products in themselves will generate large stresses in the grain boundaries because they occupy a greater volume than the original material. This action is analogous to the bursting forces produced by the expansion of water as it freezes in a deep crack in a stone. The combined action of selective corrosion, grain boundary stress, and bursting forces exerted by the corrosion products would rapidly propagate the intercrystalline crack.

It should be clearly understood, however, that the forces acting on the grain boundaries do not necessarily have to result from an applied load, but may arise from cold work or internal stress in the metal. This is demon-

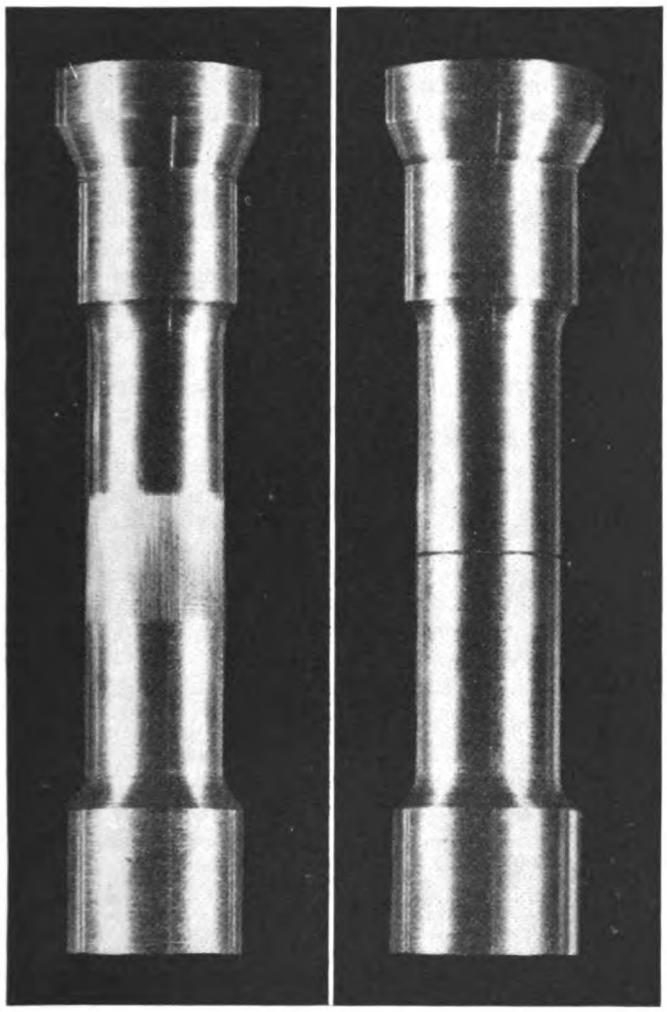


Fig. 5—Concentric-ground (left) and eccentric-grooved (right) tubular specimens of boiler flange steel used in the tension tests

strated by the cracking of a U-bend specimen without the use of a bolt to draw the ends together. In this case, however, the cracking appears on the inside of the bend because after bending and releasing the applied stress the elastic forces react to produce compression of the outer surface and tension on the inner. Fig. 4 shows such cracks as these on the inner surface of a specimen after it has been bent open slightly at the end of the test to make them more apparent. It is clear that residual stresses great enough to promote cracking of the grain boundaries may be left in the steel from cold work.

The failure of these U-bend specimens without applied load demonstrates the improbability that a riveted joint could be so fabricated that it would not fail in contact with a solution that causes intercrystalline attack. The joint could hardly be made without some cold working of the plate and rivet metal which would make it susceptible to cracking. Obviously, however, every precaution should be taken during boiler construction to cold work the steel as little as possible to keep to a minimum the area of metal in which cracking may start. The stress created by the steam pressure, while very important in designing the boiler, is probably of little significance in initiating intercrystalline cracking.

Action of Solutions in Tension Tests

The U-bend tests that have been described were largely carried out in solutions boiling under atmospheric pressure. The equipment shown in Figs. 5 and 6 was used to test for intercrystalline cracking at the higher pressures normally encountered in boiler operation.

The specimen is tubular and closed at one end. The center section is ground, or eccentrically grooved as shown in Fig. 5. The specimen is inserted in the bomb as shown in Fig. 6 and the tensile stress is applied by means of the push rod passing up through the center. The solution to be used in the test is of course put into the bomb before the specimen is inserted. It is to be noted that this design makes it possible to apply a definite tensile stress to the specimen, while it is in contact with a heated solution under pressure, without the use of a packing gland or other device that might interfere with the actual stress reaching the specimen.

The first tests in this equipment indicated that sodium hydroxide alone had little influence on the load carrying ability of concentric ground specimens made of boiler flange steel at 482 deg. F. At this temperature the steel will break at a stress slightly above 80,000 lb. per sq. in. and Table II shows that the specimens would carry a load from 65,000 to 75,000 lb. per sq. in. even in contact with the concentrated sodium hydroxide.

Table II—Resistance of Concentric Ground Tension Specimens to Failure in Sodium Hydroxide Solutions

Test temperature 482 deg. F. (560 lb., gage)

Applied stress, lb. per sq. in.	Grams NaOH per 100 grams water	No failure, days
75,000	water	43
65,000	10	19
75,000	25	21
75,000	25	43
70,000	50	10

In the U-bend specimens it will be remembered that the action of the sodium hydroxide was greatly accelerated by the introduction of certain oxidizing agents into the solution. These compounds probably tended to form a partially protective layer over the crystal faces and to intensify the corrosion at the grain boundaries. These oxidizing agents might therefore be introduced into this tension test at 482 deg. F. to accelerate the intercrystalline attack of the hydroxide. As a matter of fact these compounds do not appear to serve the same purpose at elevated temperatures, probably because they are too reactive and are destroyed too quickly by contact with the steel surface.

Table III—Failure of Concentric Ground Tension Specimens in Sodium Hydroxide-Sodium Silicate Solutions

Test temperature 482 deg. F. (560 lb., gage)

Applied stress, lb. per sq. in.	Grams per 100 grams water			Failure, hours	No failure, days
	NaOH	Na_2SiO_3	NaCl		
70,000	25	0.4	..	44	..
70,000	25	1.7	..	10	..
60,000	25	3.0	..	135	..
60,000	25	3.0	..	120	..
50,000	25	0.32	0.3	32	..
50,000	25	0.32	0.3	49	..
45,000	25	0.32	0.3	79	..
40,000	25	0.32	0.3	60	..
35,000	25	0.32	0.3	..	10

Other compounds appear, however, to produce this same type of partially protective layer at elevated temperatures, and sodium silicate is the one that most commonly appears in boiler operation. Table III shows the influence of sodium hydroxide-sodium silicate solutions on the load carrying ability of concentric ground specimens at 482 deg. F. Failure was produced in a few days at loads as low as 40,000 or 45,000 lb. per sq. in. From these results it is apparent that the sodium silicate

greatly accelerates the attack by the sodium hydroxide. Sodium chloride was added to solutions for the tests at low stress, for in low concentrations it also has been found to accelerate the cracking slightly.

The discovery that sodium silicate accelerated the attack of the sodium hydroxide solutions, especially at temperatures above 390 deg. F. (210 lb. gage) was of importance not only in understanding the cracks that occurred in boiler operation, but also in studying the action of various chemicals that might be used to prevent intercrystalline cracking. These chemicals could be introduced into the test equipment as shown in Fig. 6 with the sodium hydroxide-sodium silicate solution and if they prevented failure of the specimens they might be useful in boiler operation to eliminate cracking of the steel.

Tests have been run in this equipment similar to those shown in Table III at 302, 392, and 572 deg. F.; corresponding to 54, 210 and 1,280 lb., gage. This work has determined the influence on the failure time of practically all the inorganic ions present in the boiler water. It has also determined the lowest and highest concentration of sodium silicate and sodium hydroxide that had a measurable influence in producing cracks or failure. Many of the data have already been reported in the technical literature.* One point is, however, of particular interest; that is, the lowest concentration of sodium hydroxide which has ever been found to produce an appreciable reduction in load-carrying ability is approximately 7.5 grams per 100 grams of water.

* Schroeder, W. C., Berk, A. A. and Partridge, Everett P. Proc. Am. Soc. Testing Materials, 36, part II, pp. 721-54 (1936); Schroeder, W. C., Berk, A. A. and O'Brien, R. A. *Metals and Alloys*, vol. 8, No. 11, pp. 320-330 (Nov., 1937); Schroeder, W. C., Berk, A. A. and O'Brien, R. A. Trans. Am. Soc. Mech. Eng., vol. 60, No. 1, pp. 35-42 (1938).

Concentration of the Boiler Water

The average boiler water does not contain more than 1,000 parts per million of sodium hydroxide. The concentrations of sodium hydroxide that have been shown to produce cracking in this report range from 7.5 to 50 grams per 100 grams of water; or from 75,000 to 500,000 parts per million. In spite of extensive effort no investigator has ever been able to show that dilute alkaline solutions, approximating the composition of actual boiler waters, would produce intercrystalline cracks. Therefore, intercrystalline cracks in boilers have been assumed to result from the action of the boiler water after it has concentrated several hundredfold. It can now be shown, under conditions of boiler temperature and pressure, that this assumption is true.

The only areas in a boiler in which the water could concentrate are those at least partially isolated from the main body of the water, such as may occur in riveted joints or rolled-in tube ends. Since intercrystalline cracking has never been definitely shown to occur in an operating boiler outside of these two areas they must combine the action of a number of factors that promote the intercrystalline attack on the steel, of which concentration is one.

Two mechanisms might be suggested to explain the concentration of a boiler water in a riveted seam or tube seat. Fig. 7 shows diagrammatically a cross section of a riveted boiler seam. For the first concentration mechanism, it is assumed that the seam is tightly caulked on the outside butt strap. The inner butt strap has a very

Table IV—Tests with Sodium Sulphate on Eccentric-Grooved Specimens

Stress Applied at 482 deg. F. (560 lb., gage)

Applied stress, lb. per sq. in.	Grams per 100 grams H_2O			Failure, hours
	NaOH	Na_2SiO_3	Na_2SO_4	
40,000	25	0.16	16	120
40,000	25	0.16	16	36
40,000	25	0.32	Saturated*	5
40,000	25	0.18	Covered†	56
30,000	25	0.16	Covered†	80
40,000	25	0.35	Covered†	24

* Saturation is 29 grams Na_2SO_4 per 100 grams H_2O at 482 deg. F. Rotated 24 hours to insure saturation.
† Specimen covered with loose crystals of sodium sulphate.

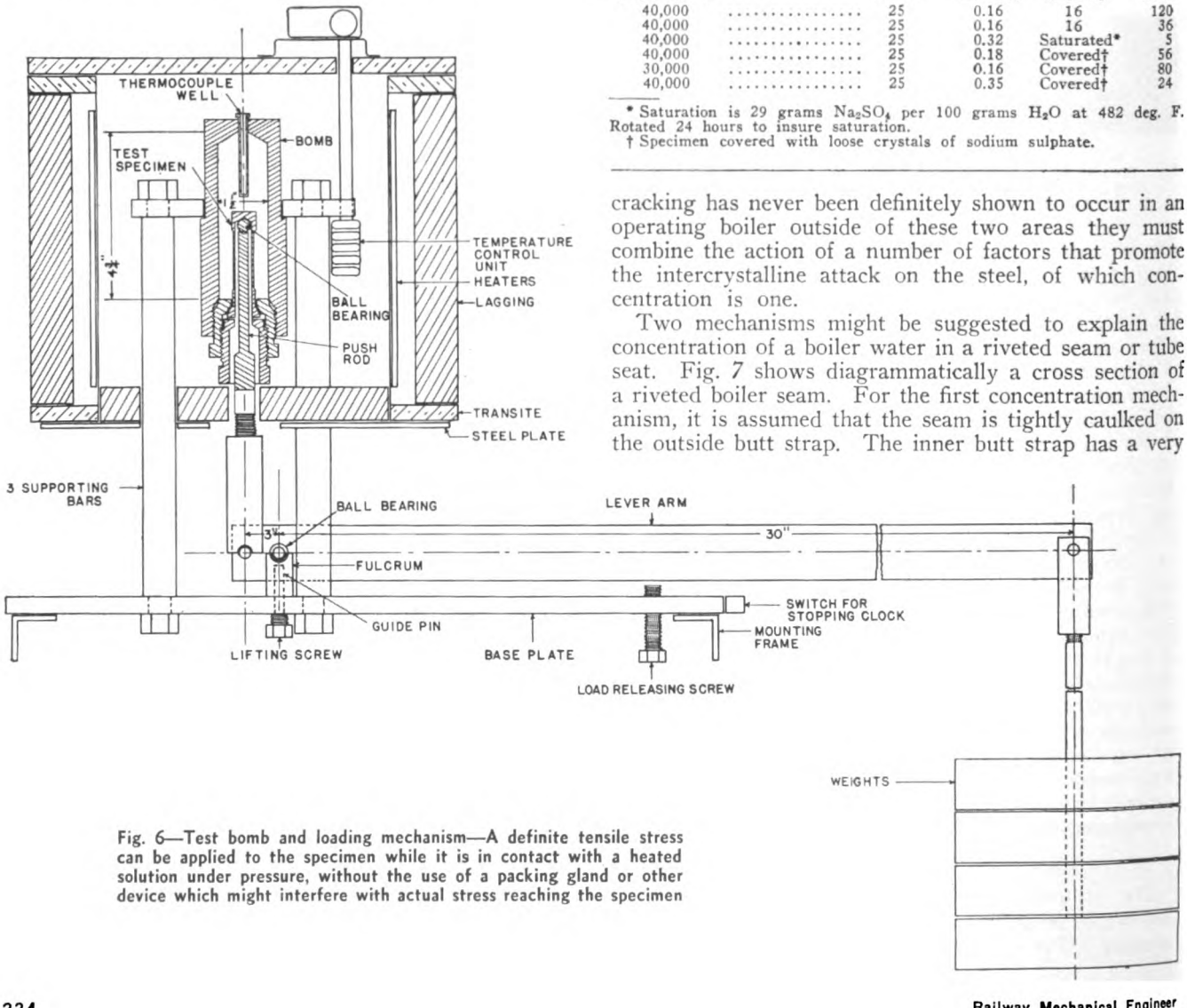


Fig. 6—Test bomb and loading mechanism—A definite tensile stress can be applied to the specimen while it is in contact with a heated solution under pressure, without the use of a packing gland or other device which might interfere with actual stress reaching the specimen

small capillary opening at *A*, and space *B* appears below *A*. The boiler pressure may fill *B* with solution and if the metal is hot enough the water will evaporate through *A* back into the boiler. When evaporation is completed the water from the boiler will tend to creep back through the capillary to condense a portion of the steam and let a few drops of solution enter *B* that will again evaporate. Eventually a concentrated solution or solid fills space *B*.

This process has been tested under atmospheric pressure in glass equipment with conditions essentially as pictured at *A* and *B* in Fig. 7. Concentrated solutions and even solid were produced in the capillary tube that corresponded to space *B*. Straub** ran somewhat similar experiments a number of years ago, forcing the water into *B* by increasing the pressure on the main body of water and then allowing evaporation to proceed by decreasing this pressure. This process also gave a concentrated solution.

This method could operate only if the riveted joint is receiving heat or if the pressure changes are extremely sharp. A concentrated sodium hydroxide solution boils at temperatures well above those required for dilute solutions. Therefore, to remove steam from such a solution in *B* against the boiler pressure would require that the metal be at a higher temperature than the boiler water. If the metal receives heat this is possible, but intercrystalline cracks have been found in riveted seams that do not receive heat and that would not presumably cause evaporation of the concentrated solution against the boiler pressure.

Table V—Effect of Lignin-Containing Materials in Preventing Failure of Eccentric-Grooved Specimens

Stress Applied at 482 deg. F. (560 lb., gage)

Applied stress, lb. per sq. in.	Grams per 100 grams H_2O			Lignin* material	No failure, days
	NaOH	Na_2SiO_3	NaCl		
40,000	25	0.16	..	1.6	10
40,000	25	0.8	..	1.6	12
50,000	25	0.8	..	1.0	10
60,000	25	0.8	..	2.0	10
50,000	25	0.8	0.5	2.0	10
50,000	25	3.2	..	4	10
40,000	50	3.0	..	1	10

* Dry powders produced from waste sulphate liquors.

Every boiler operator has seen concentration by the second method when he observes the deposits of solid on the outside of a seam, or rivet that is slowly leaking. Essentially the process demands the leakage or diffusion of solution past a restriction much more slowly than water evaporates toward the atmosphere. If this leakage and evaporation occurs at the exposed edge of the butt strap, it probably does little damage since the concentrated solution is in contact with drum metal that is not cold worked or under high stress.

If, however, the concentration should occur down in the seam or along a rivet a different situation exists. For example, in Fig. 7 the lower rivet may contact the metal only at point *D* on the one side. If boiler water leaks very slowly past *D*, the drop to atmospheric pressure at *C* will cause evaporation of the water to produce solid and a concentrated solution. Immediately, under the head of the rivet, a range of concentrations may exist as follows: (1) Dilute boiler water; (2) steam and more concentrated water; (3) steam, concentrated water, and solids; and (4) solids and a small amount of water.

If the rivet has been cold worked or is under high stress some solutions in this range may start cracking that will proceed until the head of the rivet comes off. This concentration mechanism could produce similar solutions in the seam and cause cracking in the butt strap, or in the drum metal.

The occurrence of intercrystalline cracks in an operating boiler indicates the simultaneous presence of at least four factors:

(1) A boiler water which when concentrated will produce intercrystalline cracking. The laboratory evidence now indicates that a water containing sodium hydroxide-sodium silicate will fall into this class if it does not contain an effective protective agent.

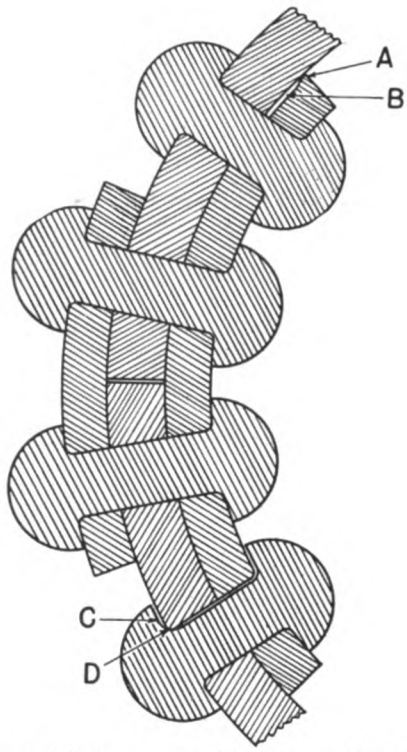


Fig. 7—Diagram of boiler seam to illustrate possible methods of concentration

(2) High stress in the metal. This may result either from residual stress from cold work or from external applied stress. In a riveted joint or rolled-in tube the effect of cold work would normally be more pronounced than the action of an applied stress.

(3) Very slow leakage in certain areas of the boiler that will allow the formation of a film of concentrated solution. Evaporation into the boiler, in case the metal is receiving heat, might also produce such a film.

(4) Contact of the film of concentrated solution with the highly stressed boiler metal.

Protection Against Intercrystalline Cracking

On the basis of the four factors that cause intercrystalline cracking it is possible to list certain steps that may be taken to eliminate the difficulty.

First, an attempt may be made to treat the boiler water chemically so it will not cause cracking even though its concentrated solution is in contact with stressed steel. The major portion of the study of protection during this investigation has been devoted to finding and testing chemicals that might be satisfactory for this purpose.

Second, an attempt might be made to reduce cold work or other stresses in riveted steams and tube ends. Complete elimination of cold work is impossible, for rivets cannot be driven and tubes cannot be rolled to make them tight without some cold work. Excessive pressures, and excessive distortion of the metal should, however, be

** Straub, F. G., University of Illinois Engineering Experiment Station Bulletin No. 216, 1930.

avoided. Other means can also be used to reduce cold work. For example, boiler plate that is bent cold to form the drum should be annealed before the riveting is done. The careful annealing usually accorded welded drums is especially commendable in this respect.

Third, an attempt might be made to eliminate leakage and possible concentration of the boiler water. This would be difficult because the type of leaking that causes the greatest damage releases an almost undetectable amount of vapor or steam. Also even if the boiler were made thoroughly tight, thermal or mechanical changes might start slow leakage.

In stationary boilers leaks in seams have been eliminated by the use of welded instead of riveted construction. This is of course a very desirable procedure wherever it can be used, and leaves the tube seat the only point for the solution to concentrate.

Chemical Treatment to Prevent Intercrystalline Cracking

The use of sodium sulphate is now recommended by the A. S. M. E. Boiler Code for the prevention of intercrystalline cracking. Practical evidence from many years of boiler operation has frequently been interpreted to indicate that this salt would stop the trouble.

In the tension testing bomb, as indicated in Fig. 6, sodium sulphate has not, however, given satisfactory results in preventing failure of the specimens. These tests have been run at 302, 392, 482 and 572 deg. F.; corresponding to pressures of 54, 210, 560 and 1,280 lbs. per sq. in., gage.

Table IV shows the results of a series of tests with sodium sulphate on eccentric grooved specimens at 482 deg. F. The stress was applied at operating temperature and failure occurred in every case. This is typical of the results secured at these temperatures. The sodium sulphate will offer more protection to the specimens when the stress is applied at room instead of elevated temperature, but even this effect is destroyed by higher concentrations of sodium hydroxide. A more detailed discussion of the tests with sodium sulphate will be found in an earlier paper.†

At 356 deg. F. (130 lb., gage) the action of sodium sulphate has also been tested in equipment for producing intercrystalline cracking in a stressed steel specimen that is in contact with a concentrated solution resulting from the slow leakage of a dilute boiler water past a restriction toward a region of lower pressure. Ratios of sodium sulphate to sodium hydroxide from 1 to 1, to 10 to 1 were tried and did not prevent the development of intercrystalline cracks and failure of the steel. It is believed the conditions existing in this equipment represent very closely those that cause cracking in the actual boiler. The laboratory results do not so far offer support for the belief that sodium sulphate will prevent intercrystalline cracking.

A large number and perhaps the majority of boilers in this country use feedwaters containing sodium hydroxide and sodium silicate and these waters are potentially capable of producing intercrystalline cracks. Some of them contain sodium sulphate and others are treated with it to maintain certain ratios of sulphate to alkalinity. In the majority of cases where this treatment has been used no cracking has occurred and it has been concluded that the sodium sulphate was responsible for the protective action.

This conclusion implies, however, that it is only necessary to have an embrittling water present in the boiler to cause cracking. This is not true, for at least three other factors must be present at the same time; high stresses in the steel, concentration of the boiler water, and contact of the stressed steel with this concentrated solution. If no control or information on these last three factors are available it is impossible to tell if the sodium sulphate prevented failure, or if failure would not occur regardless of the presence or absence of this salt. Briefly this means that lack of cracking in an operating boiler is not necessarily a criterion to indicate the non-embrittling action of the water. Reported cases of boilers operating for many years without cracking, using high alkalinities and little or no sulphate or other specific treatment to prevent intercrystalline cracking, furnish considerable support for this statement.

This reasoning does not necessarily imply that all boiler waters containing sodium hydroxide and sodium silicate will cause intercrystalline cracking even when their concentrated solution is in contact with the stressed steel. For example, the laboratory work has revealed certain organic chemicals that will inhibit the selective intercrystalline attack by the solution. Some of these compounds are present in certain feedwaters. Other unappreciated effects of certain chemicals may still be discovered although many of the compounds present in a normal boiler water have been very thoroughly investigated.

Certain organic materials have been found which were much more effective in preventing failure or cracking of the steel specimens than any inorganic chemical that has been tried. Lignin containing materials were very satisfactory, and are available at low cost in the waste sulphite liquors resulting from the manufacture of paper. For boiler use the waste liquors are generally evaporated to a dry powder or a solution containing 50 per cent dissolved solid. One railroad in the United States has used these concentrated solutions continuously for over ten years. The results indicate that this treatment was probably responsible for the elimination of cracking in a large number of locomotives each year. The treatment has not created difficulties in the way of scale formation, corrosion, or foaming, and in fact may have some desirable influence toward counteracting these troubles. The use of sulphite waste liquors is now being tried on several other railroads and in some stationary plants.

Table V shows the effectiveness of lignin materials produced from waste sulphite liquors in preventing failure of the eccentric grooved specimens at 482 deg. F. Specimens did not break with ten days in spite of high applied stress or high sodium hydroxide concentrations. If these results are compared with those in Table IV it can readily be seen that the lignin containing materials are much more effective than sodium sulphate in preventing failure.

Cutch and quebracho have also been found to be very effective in preventing intercrystalline cracking. Preliminary results indicate that the quebracho may be especially useful at low pressure. Both of these compounds are frequently used in feed-water treatment and their introduction into the boiler can be made with considerable background of experience. The protective action of these materials is receiving further study.

Several tests have shown that the ratio between waste sulphite liquor, cutch or quebracho and sodium hydroxide in the feedwater is not maintained in the boiler. These compounds may react with oxygen in the boiler and are adsorbed or carried down to some extent with any solid that may precipitate. Therefore, to make sure of the desired concentration it is necessary to analyze the boiler water. This is especially true during installation of the treatment to establish the correct ratio of treating chemical to sodium hydroxide in the feedwater. An analyti-

(*Continued on page 339*)

† Trans. A.S.M.E., vol. 60, January, 1938, pp. 35-42.

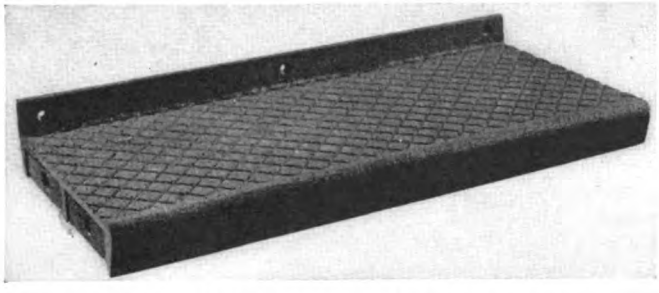
Examples of Recent Locomotives of the 4-6-4 Type

General Dimensions, Weights and Proportions

Railroad	A. T. & S. F.	B. & O.*	B. & A.	Can. Nat.	Can. Pac.	Can. Pac.	C. & N. W.	C. B. & Q.	C. M. St. P. & P.	D. L. & W.	Me. C.	N. Y. C.	N. Y. C.	N. Y. C. & St. L.	N. Y. N. H. & H.
Builder	Bald.	R. R.	Lima	Mont.	Mont.	Mont.	Am.	Bald.	Bald.	Am.	Bald.	Am.	Am.	Lima	Bald.
Road class	3460	Lord Balt.	J-2C	K-5a	H-1a	H-1c	E-4	S-4	F-6a	.....	.....	J-1c	J-3a	L-1f	I-5
Road numbers	3460-65	2	610-619	5700-04	2800-09	2820-49	4001-09	3000-11	6414-21	1151-55	701-02	.....	.....	174-177	1400-09
Date built	1937	1935	1930	1930	1929	1937	1938	1930	1931	1937	1930	1929	1937	1929	1937
Weights in Working Order															
On drivers	213,440	156,000	188,100	188,600	183,800	186,800	216,000	207,730	196,550	198,000	171,400	188,500	196,000	176,000	193,000
On front truck	83,950	45,000	67,100	66,000	63,100	61,500	87,000	69,320	76,970	82,000	55,520	61,500	66,000	53,500	71,500
On trailing truck	114,990	93,000	101,800	101,800	104,300	105,700	109,000	114,830	106,700	97,000	85,670	101,000	98,000	84,500	100,800
Total engine	412,380	294,000	357,000	356,400	351,200	354,000	412,000	391,880	380,220	377,000	312,590	351,000	360,000	314,000	365,300
Tender, loaded	396,340	199,800	209,800	305,800	291,900	288,650	360,000	326,020	287,780	313,100	189,610	279,000	314,300	206,200	332,000
Engine and Running Gear															
Cylinders, diam. and stroke, in.	23½x29½	19x28	25x28	23x28	22x30	22x30	25x29	25x28	26x28	26x30	23x28	25x28	22½x29	25x26	22x30
Driving wheels, diam., in.	84	84	75	80	75	75	84	78	79	80	73	79	79	73	80
Driving wheel base, ft. and in.	14–6	14–10	14–0	14–0	13–2	13–2	14–8	13–8	14–0	14–0	13–0	14–0	14–0	13–0	14–0
Engine wheel base, ft. and in.	14–1½	42–10½	40–4	40–2	39–6	39–6	42–4	39–11	40–9	40–7	35–8	40–4	40–4	37–9	40–1
Engine and tender wheel base, ft. and in.	88–8	81–6½	76–1½	79–4⅝	80–6¼	80–6¼	88–11¾	82–2¾	81–7½	81–2½	72–4¼	83–7½	83–7½	73–7¾	84–10
Boiler															
Steam pressure, lb. per sq. in.	300	350	240	275	275	275	300	250	225	245	240	225	275	215	285
Diam. first ring, in.	88	72	84¼	78	78½	78½	88⅝	82	82	82	78½	82⅞	80⅝	83⅛	82⅞
Firebox length, in.	132	114	130	126⅛	131⅛	131⅛	157	131⅞	120	130½	120⅛	130	130⅝	114⅛	132
Firebox width, in.	108	78	90¼	84⅝	88⅞	88⅞	83⅝	96	96	90½	75¼	90¼	90¼	84¼	84⅛
Tubes, number and diam., in.	46–2¼	120–2¼	37–2¼	44–2¼	62–2¼	58–2¼	8–2	62–2¼	58–2¼	231–2	42–2¼	37–2¼	59–2¼	224–2¼	199–2¼
Flues, number and diam., in.	200–3½	27–5½	201–3½	146–3½	171–3½	171–3½	196–3½	184–3½	182–3½	52–5⅝	166–3½	201–3½	183–3½	45–5½	48–5½
Length over tube sheets, ft. and in.	21–0	25–0	20–6	19–1	18–3	18–3	19–0	19–0	19–0	17–6	20–0	20–6	19–0	20–0	18–0
Fuel	Oil	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal
Grate area, sq. ft.	98.5	61.75	81.5	73.7	80.8	80.8	90.7	87.9	80	81.5	62.6	81.5	82	66.7	77.1
Heating Surfaces, sq. ft.															
Firebox and comb. chamber	280	612	244	253	288	288	367	326	307	350	220	244	323	232	341
Arch tubes and syphons	95	.....	37	92	38	38	140	43	100	127	86	108	37	70	139
Firebox, total	375	612	281	345	326	326	507	369	407	477	306	352	360	302	480
Tubes and flues	4,395	2,727	4,203	3,032	3,508	3,465	3,472	3,878	3,794	3,377	3,520	4,203	3,827	3,917	3,335
Evaporative	4,770	3,339	4,484	3,377	3,834	3,791	3,979	4,247	4,201	3,854	3,826	4,555	4,187	4,219	3,815
Superheating	2,080	880	1,920	1,492	1,640	1,640	1,884	1,830	1,815	1,123	1,760	1,951	1,745	1,045	1,042
Comb. evap. and superh.	6,850	4,219	6,404	4,869	5,474	5,431	5,863	6,077	6,016	4,977	5,586	6,506	5,932	5,264	4,857
Tender															
Water capacity, U. S. gal.	21,000	10,000	10,000	16,800	14,400	14,400	20,000	15,000	15,000	15,800	10,000	12,500	14,000	11,000	18,000
Fuel capacity, tons or gal.	7,000	16	17	20	20	21	25	24	20	26	14	24	30	16	16
General Data, estimated															
Tractive force, engine, lb.	49,300	34,000	44,800	43,300	45,300	45,300	55,000	47,700	45,880	52,800	41,300	42,300	43,440	40,680	44,000
Tractive force, booster, lb.	.....	7,000	10,600	10,100	.....	.....	.....	11,700	.....	.....	12,200	10,900	12,100	.....	.....
Piston speed, 10 m.p.h., ft.	196.7	186.7	209.1	196.1	224.1	224.1	193.3	201.0	198.6	210.1	214.8	198.6	205.6	199.5	210.1
Weight Proportions:															
Wt. on drivers ÷ wt. engine, %	51.8	53.1	52.7	528	52.3	52.8	52.4	53.0	517	52.5	54.9	53.7	54.45	51.1	52.8
Wt. on drivers ÷ tractive force	4.33	4.59	4.20	4.35	4.06	4.12	3.93	4.35	4.28	3.75	4.15	4.46	4.51	4.32	4.38
Wt. of engine ÷ comb. h. s.	60.2	69.7	55.7	73.2	64.1	65.2	70.3	64.5	63.2	75.7	5.60	53.9	60.69	59.7	75.2
Boiler Proportions:															
Firebox h. s. percent comb. h. s.	5.47	14.5	4.39	7.08	5.95	6.00	8.65	6.07	6.77	9.59	5.48	5.41	6.07	6.74	9.90
Tube-flue h. s. percent comb. h. s.	64.16	64.6	65.6	62.3	64.1	63.8	59.2	63.8	63.1	67.84	63.0	64.6	64.52	74.4	68.65
Superh. surface percent comb. h. s.	30.4	20.85	30.0	30.6	29.9	30.2	32.15	30.15	30.15	22.57	31.5	30.0	29.42	19.85	21.45
Firebox h. s. ÷ grate area	3.91	9.91	3.45	4.68	4.03	4.00	5.59	4.20	5.09	5.85	4.89	4.35	4.39	4.53	6.23
Tube-flue h. s. ÷ grate area	44.60	44.15	51.6	41.15	43.4	42.9	38.27	44.1	47.5	41.4	56.2	51.5	46.68	58.7	43.25
Superh. surface ÷ grate area	21.11	14.25	23.55	20.25	20.3	20.3	20.78	20.8	22.7	13.78	28.1	23.95	21.28	15.67	13.52
Comb. h. s. ÷ grate area	69.62	68.31	78.60	66.08	67.73	67.20	64.65	69.1	75.29	61.03	89.19	79.80	72.38	78.90	63.10
Tractive force ÷ grate area	500	551	550	587	561	561	606	543	561	648	659	519	529.8	610	571
Tractive force ÷ comb. h. s.	7.19	8.05	6.99	8.89	8.27	8.34	9.37	7.85	7.63	10.6	7.39	6.50	7.32	8.36	9.06
Tractive force × diam. drivers ÷ comb. h. s.	604	676	524	710	621	625	787	612	603	849	540	513	578.5	611	725

Non-Skid Flooring And Stair Treads

A non-slip safety metal, which is highly resistant to rust and acid corrosion and unaffected in its non-slip properties by water, oil or other slippery liquid substances, is being manufactured by the American Brake Shoe and Foundry Company, New York. This product, marketed under the trade name of non-slip ABSCO metal, is formed by applying electric-furnace abrasive grains, the best anti-skid and hardest material known,



Non-slip ABSCO tread formed by applying abrasive grains to ferrous or non-ferrous products by a special method of casting

to cast iron, bronze, aluminum or nickel silver, by a special process of casting. The abrasive grains are deeply and uniformly bonded into the metal at the time of casting, thus forming a virtually indestructible bond between the abrasive grains and the metal. The grains protrude sufficiently above the surface to give a "bite" to the metal which, it is said, eliminates all possibility of slipping.

This casting process makes possible a wear- and corrosion-resistant "nose" to stair treads, since the abrasive grains are carried entirely over the "nose" and concentrated at this vital slipping point. Sluffing out and loss of abrasive grains, due to corrosion along the "nose," are prevented by this method, as no grinding is necessary to remove raw films of metal on the casting ridge.

ABSCO metal is designed for use as stair treads, ramps, industrial floors, platforms, elevator door sills, swing-type door thresholds, trench covers, etc.

Lightweight Coach Seat

A new design of railway coach seat has recently been developed by the Transportation Seat Company, McCormick Building, Chicago, this seat being notable for its light but strong construction, unique rotating, reclining-back design and modern styling to provide a wide popular appeal. The cushion height and pitch, degree of recline of the original back position, height of the back and the arm rests, have all been worked out by architects and engineers familiar with these specialized problems to produce a seat design which will assure the greatest degree of riding comfort combined with attractive styling.

Individual coach seats of the new design weigh from 105 lb. to 115 lb., which is said to be roughly 25 per cent less than the present generally accepted standard for lightweight seat construction, or 50 per cent of the weight of the first revolving-reclining seats built for railway service in this country. The saving in weight is effected without the use of alloy metals and attendant increase in cost, ordinary carbon steel tubes and plates being combined in an efficient welded design.

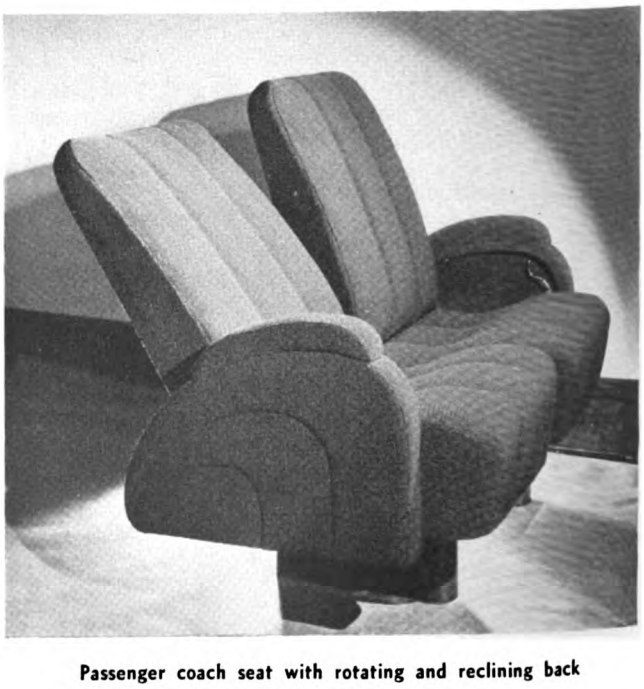
The patented base allows seats of approximately 44 in. overall arm width to rotate independently on 39 in.



The seat with cushions removed to show rigid frame construction

to 40 in. centers with a clearance at the wall of ¼ in. to ⅜ in. without the necessity of pulling the seat away from the wall. The seat base is made of a combination of steel plates and tubing of welded construction, without moving parts. The entire mechanism requires a depth of only approximately ¾ in. A ball-type locking device eliminates the possibility of the seat turning due to any unusual motion of the train. The frame is of tubular steel construction, re-inforced with gussets and entirely welded throughout. The reclining mechanism for the independently reclined backs is of the unit type, lever operated, fully enclosed and applied directly to the seat frame. It may be removed as a unit.

The backs, mounted on roller bearings, are of steel tubing and plywood construction with either rubber or spring cushions. Seat cushions are of rubber or spring construction. The arms are wood, aluminum, or tubing. Arms, caps and cushions are removable.



Passenger coach seat with rotating and reclining back

Analysis of Driving-Axle And Crank-Pin Failures

During the June 29 meeting of the General Committee of the Mechanical Division, Association of American Railroads, at which the reports of the year's work of a number of the standing and special committees were presented, a progress report on failures of driving axles and crank pins* was presented by W. I. Cantley, mechanical engineer of the Mechanical Division. It is the intention of the committee considering this subject to make further studies. For the present these studies will be confined to crank pins only, since the subject of driving axles is to be given consideration following the tests now being conducted at the Timken laboratory on passenger-car axles. It is the belief of the committee that if the members receiving copies of the report will analyze it carefully, they may find information in it which will be helpful to them in reducing failures on axles and crank pins similar to those now being experienced.

The following paragraphs are a summary of the major findings of the committee based on an analysis of the reports of the questionnaire sent by the Mechanical Division December 2, 1936, to 38 railroads in the United States and Canada and to which replies were received from 34 railroads. The report is confined to failures of axles and crank pins in actual service, but in the further study which the committee proposes to make they will also include crank pins which were found defective upon inspection.

Driving Axle Failures

During the six-year period ended December 31, 1936, 895 driving-axle failures on 864 steam locomotives in freight and passenger service were reported by 34 railroads owning 70 per cent of the total number of locomotives in service in the United States and Canada.

The average rate of failures reported is approximately six driving axle failures per year per 1,000 locomotives in service.

There were approximately seven times as many failures of main driving axles as there were of other driving axles.

On freight locomotives, 80.7 per cent of all driving axle failures occurred in the journal. On passenger locomotives, 41.7 per cent of all driving axle failures occurred in the journal and 55.0 per cent occurred in or near the wheel seat.

No definite causes were given for 47.6 per cent of all driving axle failures. No definite cause was given for 68.8 per cent of failures in the wheel fit. The principal causes of driving axle failures in the order of frequency of occurrence are: Overheating in service, 67.6 per cent of known causes; poor material, 14.9 per cent; poor machining, 12.8 per cent; service conditions—wear primarily, 4.7 per cent.

A large number of failures at the wheel seat occurred on driving axles for which the reported actual diameter was smaller than the nominal journal diameter. There were fewer failures in or near the wheel seat of alloy steel driving axles than of carbon steel driving axles.

The fibre stresses of the majority of failed driving axles were below the A. A. R. recommended limit of 23,000 lb. per sq. in. The indications are that the limit of 23,000 lb. per sq. in. is too high, and that a reduction of this limit to 20,000 lb. per sq. in. would do much to reduce axle failures.

Check tests show a wide variation in physical properties of steel both for driving axles and crank pins manufactured to the same specifications.

Crank Pin Failures

During the 6-year period ended December 31, 1936, 830 crank pin failures on 799 steam locomotives in freight and passenger service were reported by 33 railroads owning 68 per cent of the total number of locomotives in service in the United States and Canada.

The average rate of crank pin failures reported is approximately five failures per year per 1,000 locomotives in service.

There were approximately four times as many failures of main crank pins as there were of all others.

On freight locomotives, 84.8 per cent of all crank pin failures occurred at or near the outside face of the wheel. On passenger locomotives, 90.1 per cent of all crank pin failures occurred at or near the outside face of the wheel.

No definite causes were given for 64.4 per cent of all crank pin failures. No definite cause was given for 72.5 per cent of failures in the wheel fit. The principal causes of crank pin failures in order of importance are: Poor machining, 54.9 per cent of known causes; poor material, 21.0 per cent; service conditions—wear primarily, 19.0 per cent; overheating, 5.1 per cent.

The fibre stresses of the majority of the failed crank pins were above the A. A. R. recommended limit of 16,000 lb. per sq. in. The indications are that a reduction in the limit to 15,000 lb. per sq. in. would greatly improve conditions.

Conclusions

The analysis of the returns clearly indicates that further study and research relating to driving axle and crank pin failures are required. Among important matters which should receive prompt and intensive consideration are:

(1) The incompleteness of many returns indicates the need for a more intensive and specific analysis of driving-axle and crank-pin failures as they occur.

(2) The cause of overheating of axles and crank pins and means of reducing the difficulty.

(3) The fatigue characteristics of those steels used in making crank pins and axles. This study should include the question of (a) whether fatigue strength requirements should be incorporated in material specifications and (b) what change should be made in the fibre stress limits.

(4) The design of and shop practices relating to axles and crank pins.

* This report is published by the Mechanical Division and is available for general distribution to members at 50 cents per copy and to non members at $1 per copy. It consists of 78 pages, 8 in. by 10½ in., and is bound in paper.

Cracking of Boiler Steel

(*Continued from page 336*)

cal method has been worked out that may be used for any of these three chemicals. It is a colorimetric method, free from interference from the inorganic and from most of the organic constituents in the boiler water. Like most colorimetric methods it has the disadvantage of not being usable on highly colored waters. An attempt is being made to work out a precipitation method for such samples.

While these organic materials appear quite satisfactory for use in locomotive operation to prevent intercrystalline cracking, it is also desirable to have inorganic chemicals that would serve the same purpose. This would be especially true if the inorganic compounds were stable and of known controllable composition. Work in this direction should be and is now being done.

EDITORIALS

Are Wage Rates The Whole Issue?

Following negotiations between the Carriers' Joint Conference Committee, on the one hand, and the Railway Labor Executives' Association and the Brotherhood of Railway Trainmen, on the other, which began late in June, the proposal of the railroads of a 15 per cent reduction in wage rates is now in the hands of the National Mediation Board which has had the matter under consideration since August 11. Considering the course of the negotiations which led up to the 10 per cent wage reduction which became effective February 1, 1932, the attitude of the leaders of the labor organizations represented in the present negotiations is disturbing in the extreme to those who have hoped to see the railway industry restored to health. The hint of "after us the deluge" in the attitude of the spokesmen for this group offers little apparent basis on which to build a structure of mutual respect and confidence in the future. Hope lies in the possibility—even probability—that a substantial majority of the men who regard railroading as a career are not in agreement with this attitude of complete irresponsibility for the future welfare of the industry.

A. F. Whitney, president, Brotherhood of Railway Trainmen, at the outset of the present wage negotiations said that "Regardless of economic conditions, I desire to make plain to you gentlemen that any effort or attempt on your part to bring about a cut in wages and a lessening of the buying power of your employees is an attempt to defeat the efforts of President Roosevelt and of every person interested in economic recovery to save this nation, and it will be resisted by every power at our command." Later Mr. Whitney said: "To destroy the purchasing power of railroad workers by more than one quarter billion dollars a year will do nothing more nor less than prevent recovery. Reduced buying power means the bankruptcy of the railroads of this country. You cannot, and will not, solve your problems by continuing to pay interest to the bondholders by taking this money from the pockets of the railroad workers."

Intelligent Selfishness

At the outset, let it be clearly understood that we are presenting no argument in favor of an attitude of unselfishness on the part of the railway employees whose wages the railways propose to cut. It is our hope that they may exercise such a degree of intelligence that they may *best* serve their selfish interests. To insist upon the immediate advantage of the reduced number of employees fortunate enough to remain on the payroll under present conditions is not serving the best interests of railway men at large or even of all of those at the present time actually employed.

A wage-rate increase is an added cost of production before it is added to purchasing power. Conversely, a wage-rate decrease effects a reduction in the cost of production to a greater extent than it reduces purchasing power, for the reason that a large part of the market for the products of industry and transportation lies outside the employed group of industrial and transportation workers.

Mr. Whitney's fear lest labor let something get away to the bondholders, at a time when approximately a third of the railway mileage in the United States is being operated by receivers or trustees and companies owning approximately half the mileage have been earning less than operating expenses for months, is a bit far fetched. It also ignores one of the basic conditions for any sound industrial and business recovery; that is, the restoration of the flow of capital into the transportation machine, as well as into other industry. Much railway traffic comes from the heavy goods industries which produce most of the goods purchased by capital expenditure, and an effort which, if successful, will prevent a re-establishment of this essential condition is not serving the interests of American workers at large or of railway employees themselves.

The immediate beneficiaries of a successful outcome of the course pursued by the railway labor organizations will be the relatively small group of trainmen and enginemen who have suffered little if at all during the present depression, thanks to mileage hogging. To the extent that traffic is offered, the employment of these men is safe. The number of employees in the mechanical department, however, can be reduced and, in fact, was reduced following the wage increase a year ago in order that the total outlay for maintenance might be kept within the funds available.

But why attempt to establish facts and build sound arguments upon them? The apparent muddiness of thinking on the part of many labor leaders during recent months suggests either a failure to understand that a system of private ownership cannot survive under conditions tending toward a permanent state of bank-

ruptcy, or a deliberate, but concealed, purpose of using the present crisis in the railway industry to effect the complete destruction of the present system of private ownership.

For some time there has been increasing evidence of an infiltration of economic and social ideas in the popular thinking which suggest the work of adherents of European left-wing philosophy. By and large, those holding such opinions realize neither their source nor their ultimate implications.

The communist's goal is a classless society in which there will be no display of selfishness because there will be no occasion for it. Each individual will be subject to the dictatorship of the whole of society. Paradoxically enough, this goal is to be attained by the "class struggle" in which the idea that the workers are at war with the rest of society is heavily stressed and in which appeal is to the selfishness and cupidity of the "masses" who, by and large, are the dupes of the left-wing leaders.

Since the class struggle is warfare, its conduct calls for complete suspension of the everyday rules of moral conduct. Lying and deception are "honorable" means of prosecuting the struggle in the minds of those who accept the doctrines of communism.

Where Do Railway Men Stand?

This raises a serious question which should be faced by all those who believe in the basic soundness of the present economic and social system and particularly by those who wish to see the railway industry restored to health. One cannot say that a particular labor leader is a communist, unless he admits the fact, but the very character of communistic doctrines creates a presumption that those leaders who are participating in the prosecution of a communistic program are adherents of the cause themselves, even in the face of their denials.

American railroad men had better make up their minds where they stand on the issue of the preservation and improvement of what we now have, or its destruction and replacement by something unknown and uncertain which may evolve out of the chaos of destruction. If they decide against a philosophy and program formulated under conditions which never did and do not now exist in America, then let them deal appropriately with their subversive leaders.

Who Are They—And Why?

A good bit of fun has been poked at the so-called "success stories" in some of the popular magazines. It cannot be gainsaid, however, that such stories are read avidly by many people. Moreover, if true, or reasonably well supported by facts, they can be a great inspiration to individuals who are ambitious and striving to make their personalities more effective in the attempt to get ahead. Unfortunately much good and inspiring material is buried and lost or forgotten, because no effort has been made to assemble it and make it generally available.

What a help it would be, for instance, if more facts and human interest material were available about those men who have made large contributions to the development of cars and locomotives and to the successful administration and operation of the mechanical department.

Those who served on the committee of the American Society of Mechanical Engineers which had charge of the program for the commemoration of the ninetieth birthday of George Westinghouse, were surprised and delighted at the large amount of really worth while and hitherto unrecorded material which was contributed by people who were associated with Westinghouse in the early days, or who were in a position to disclose authentic information about his character and activities. This in spite of the fact that an excellent and comprehensive biography had been written about Westinghouse by Colonel H. G. Prout.

To begin with, who are the men who should be listed for their achievements in the railway mechanical field? In the hurry and rush of this modern age some of these men have been overlooked or almost entirely forgotten. Yet the railroads of this country are only a little more than a hundred years old. Other men labored so quietly that they never did get the recognition their achievements deserved. Whom do you nominate?

Surely a list compiled with the assistance of the readers of the *Railway Mechanical Engineer,* a paper which dates back to the very beginning of the railroad era in this country, would be a matter of great interest and value today, as well as in the future. Will you help us compile such a list? What names can you suggest, and why? What supporting data or facts or incidents or references can your furnish that will help us to present these men to our readers. With your co-operation it should be possible to dig up and place on record material which, if not disclosed now, may in many instances be lost forever. What do you think of the idea?

Motive Power Performance Not Properly Supervised

Remarkable improvements in locomotive design, efficiency and potential capacity have been effected in the past 20 years, for example, with steam pressures and superheat temperatures increased one-third, steam consumption per indicated horsepower decreased one-tenth, and potential horsepower output in some instances nearly doubled. Old locomotives have been retired and replaced by modern units as fast as practicable. The question is whether the railroads are securing maximum results from this large investment in modern power, combining as it does the latest refinements in

design with such important fuel-saving and capacity-increasing devices as up-to-date superheaters, feedwater heaters, Thermic syphons, stokers, boosters, etc.

While enviable locomotive performance records have been established in some instances, a new locomotive is no different from any other new appliance or shop tool in producing an output more or less proportional to what is demanded of it. In other words, unless the possibilities of the new tool are fully realized and adequate supervision provided to make sure that railroad men use the tool at somewhere near its maximum capacity, both while new and during its entire service life, its actual output may not greatly exceed that of the tool replaced. The answer to the question asked in the opening paragraph is that drastic reductions in supervision, including the retirement or demotion of many road foremen of engines, make it impossible for many railroads to get all the results they should with modern steam locomotives.

The following instance of locomotive misuse is believed to be typical and can probably be duplicated many times over on railroads throughout the country. Referring to the table, it will be observed that engine crews, using locomotives of identical design and hauling trains over the same division and under the same

Selected Freight Runs in One Direction on a 125-Mile Division Showing Higher Speeds Maintained by the Same Class of Locomotive in Spite of Heavier Loads

Date	Number of cars	Gross ton loading	Time to top of last grade, minutes	Aver'ge speed, miles per hour
Dec. 15	47	1612	64	25.8
Dec. 13	36	1628	62	26.6
Dec. 14	29	1669	65	25.4
Dec. 17	37	1840	61	27.1
Dec. 18	35	1942	60	27.5
Apr. 14	49	2045	60	27.5
Apr. 20	41	2105	60	27.5

atmospheric conditions, moved heavy trains faster than light trains, owing to a psychological factor which, with proper supervision, could be capitalized and used to help the railroads reduce operating expense instead of increasing it.

The division in question is 125 miles long and the first 27.5 miles contain four ruling grades all of which are of the momentum type; that is, it makes a great deal of difference in maximum tonnage as well as speed of operation if the hill is approached at low or high speed. Engine crews on the runs referred to apparently had a schedule in their minds which they kept regardless of tonnage. Naturally, with the lighter tonnage they were not so keen about keeping up speed, as they realized that the grades would give them no serious difficulty. When the tonnage exceeded 1,800, however, there was some anxiety in their minds as to whether they would get over if they allowed the speed to drop. It was noticeable, therefore, that they made a serious effort to keep the speed up with heavier trains, thus resulting in a shorter time over this section of the road. The remaining 97 miles of the run were made without difficulty so far as grades were concerned, it being an easy task to maintain the maximum speed limit of 40 miles an hour. The figures quoted plainly show that, in the instance cited, the engine crews could and did get more out of their locomotives when they had to, but slackened their efforts when the going was easy.

The result of failure to get maximum output from modern steam locomotives is nowhere better exemplified than in the lowering of tonnage ratings when operating schedules are tightened and running time substantially reduced in response to the demands for ever-increasing train speeds. Some managements are entirely too willing to jump to the conclusion that drastic reductions in tonnage ratings must be made whenever schedule speeds are increased. Tonnage reductions of 50 per cent are sometimes made, as evidenced by one specific case in which the tonnage rating of a rebuilt locomotive was reduced from 4,000 to 2,000 tons to meet what was admittedly a rather difficult operating assignment. In another case it was considered necessary to reduce the tonnage rating of a certain class of locomotives from 2,700 to 1,500 in order to make the time on a new schedule. As a matter of fact, with the locomotive in good condition and the engine crew on its toes to secure maximum output, it was subsequently shown that this locomotive could handle 1,800 tons and meet the operating schedule without particular difficulty.

Locomotive efficiency and railroad efficiency are both very closely allied with the average percentage of maximum power output secured in normal locomotive operation. On the basis of fuel economy as well as minimizing the number of train miles required to handle a given traffic, it is essential to operate steam locomotives as nearly as possible at their maximum power rating. This means an adequate amount of intelligent supervision, with a full appreciation of the capacity of modern motive power and a positive check on and control of engine crews to make sure that these capacities are substantially realized.

New Books

PROCEEDINGS ASSOCIATION OF AMERICAN RAILROADS, DIVISION V, MECHANICAL. *Published by the Association of American Railroads, 59 East Van Buren street, Chicago. Price, to members, $5; to other than members, $10.*

The proceedings of the session of the Association of American Railroads, Operations and Maintenance Department, Division V-Mechanical, held at the Municipal Auditorium, Atlantic City, N. J., June 16-23, 1937, contain also recommendations, letter ballots and other transactions for the year 1937. A list of the representatives at the meeting, the first full convention and exhibit since 1930, is also included.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Older Men Help Apprentices

Conditions have changed considerably since I last wrote you. Now, we have only the older men around and they realize that they will soon be on the pension list. Therefore, they are more than willing to show us everything that they have learned in the way of car repairs, inspection, including all short cuts that save both time and money for the railroad. This makes our work more interesting and we are learning more than we ever learned before.

Better Workmanship Required Today

At the present time, as never before in the history of railroading, managements are being forced to modernize motive power and rolling stock, and the back-shop equipment required to maintain and repair these new and expensive articles. New materials, new processes, closer tolerances, tighter fits, better finishes on machined work, more refinements on all equipment —all of these things complicate the modern railroad set-up, and call for a higher degree of skill in supervision and mechanics alike than ever has been known in railroading. Improved equipment soon loses its value if not cared for properly.

Intense Use of Locomotives

I noticed a statement recently that some railroads are obtaining as much as 75,000 to 125,000 miles per year from their best freight locomotives. It is reported that a Milwaukee freight locomotive made as much as 19,200 miles in October, 1934. These, however, are extremes. The average performance of freight locomotives in actual service probably does not exceed 25,000 miles a year, if indeed it is that high. Traffic today is being handled by the cream of the motive power, for undoubtedly only the best locomotives are being utilized under present conditions. What would happen under peak traffic with all the motley array of obsolete locomotives in operation, is quite another question.

Apprentices Attending Universities

I notice that arrangements can be made on the Canadian National to allow apprentices leave of absence to attend university during apprenticeship training. Three ex-apprentices are said to have completed a five-year university training in engineering and also their five-year apprenticeship. Of these, two graduated from the University of Manitoba with the degree of electrical engineer and one from McGill University with the degree of mechanical engineer. All three have been placed in the mechanical and electrical department of the railroad. At the present time four apprentices are attending university and still taking their apprenticeship training. It is found that those who take the combined apprenticeship and university training are better qualified to be advanced to supervisory positions and, no doubt, in time will make good executives.

An Apprentice Philosopher

As to schooling along the lines of shop mathematics, blueprint reading, mechanical drawing, etc., we go to night school. Some of the fellows that have been furloughed think that the time they spent in school was wasted. This really shows that they have not spent enough time in school or they would realize that an education of any kind in any type of work will never be lost time. They might not need it for their present job (that is, those that are lucky enough to have jobs), but one never knows when he will need such an education. I noticed that several apprentices wrote to you saying that they had classwork on company time. I will admit that this feature would help to a certain extent, but after all, if a fellow is really interested in his job, he is willing to do a little more than he is asked to do, or a little more than he is paid for.

Manufacturing Railway Equipment on a Production Basis

Probably one of the outstanding economic problems today is to bring down the cost of railroad equipment; namely, locomotives, passenger cars and freight cars. Practically every locomotive ordered for the various railroads is of a peculiar design; the same is applicable to both passenger train cars and freight train cars. Railroads and builders are equally responsible for this chaotic condition; however, I believe that the burden should be placed on the builders. If the builders would concentrate on one standard design; that is, a 1938 model 4-6-4 locomotive, a 1938 model passenger train coach, or a 1938 model box car, having the latest, most modern and up-to-date fixtures, at a real low cost, railroads could afford to pay the price and could be likened to an individual who would not pay the higher price for an automobile when a lower priced one would equally as well serve the purpose. It is believed that if such efforts were made by builders, savings in certain kinds of equipment up to 50 per cent could be attained, thereby having equipment at a price where railroads could afford to buy it, and create work for thousands of people.

The National Income

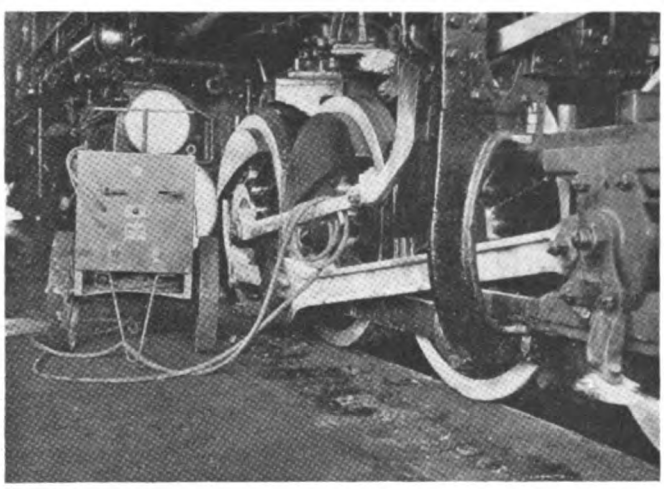
In your high spots, page 280 of the July issue, under the caption "We Wonder" you commented on the national income and its distribution. Owen D. Young, chairman of the board of the General Electric Company, in speaking on The Science of Better Living before the Industrial Personnel Institute at Purdue University last year, quoted from an article in the Yale Review by A. A. Berle, Jr., as follows: "The real object must be increase in the national income. . . . The job is to level up far more than to level down. Distribution is one problem, but if the ultimate goal is to be reached there must be a great deal more to distribute." Later in his address Mr. Young said, "I am sure that most people believe today that the preceding generation did a bad job economically. I do not share that view. If, as is estimated by the National Bureau of Economic Research, our national income was increased from $27,600,000,000 in 1909 to $86,000,000,000 in 1929—more than three times—if at the end of that period we had succeeded in distributing approximately five-sixths of that income to employees and independent operators like farmers and small business men, we ought not to be too severely critical of the economic management of the preceding generation. If the present, and those following, do as well both in production and distribution, there is real ground for hope that even the very high living standards to which we now aspire can be met."

IN THE BACK SHOP AND ENGINEHOUSE

D. & R. G. W. Installs Magnaflux Inspection

*By Ray McBrian**

The Denver & Rio Grande Western has recently installed the non-destructive Magnaflux method of test and inspection for the prevention of failures by locating incipient flaws such as surface fatigue cracks. This method of flaw detection is by a process of magnetizing the ferrous part in such a way as to create a minute magnetic pole at the edge of any flaw, such as fatigue cracks and even flaws immediately below the surface of the material. On sprinkling the part being tested with the finely-divided perimagnetic material, polarization of the part causes this powder to outline the defect which, by other methods of inspection, would remain invisible. Tests made by the old inspection method,



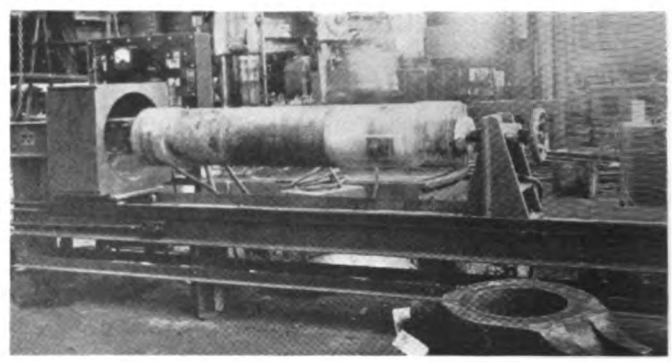
The portable outfit being used for the inspection of an eccentric rod while on the locomotive

using whiting, have shown that this magnetic method discovers many more defects than could otherwise be found.

The equipment installed on the railroad consists of a portable unit and a fixed unit at Salt Lake City, Utah, a portable unit at Grand Junction, Col., and a portable and a fixed unit at Denver, Col. These installations make for flexibility, and allow for inspection at the important main-line terminals thus insuring systematic, routine inspection of mechanical parts. The portable units can be moved to various terminals on the railroad whenever it is so desired.

The portable unit is a compact power unit designed for the inspection of large or small parts and capable of being moved to any location where power is available. It is operated by alternating-current and capable of delivering a maximum of 3,000 amp. at 20 volts. In general, with the use of this unit, parts up to 10 in. or more in diameter may be examined for transverse cracks by wrapping four or five turns of cable around the part being tested and applying the maximum amount of voltage. The field is effective for only 18 to 24 in. on either side of the coil, and for long parts the coil must be shifted accordingly.

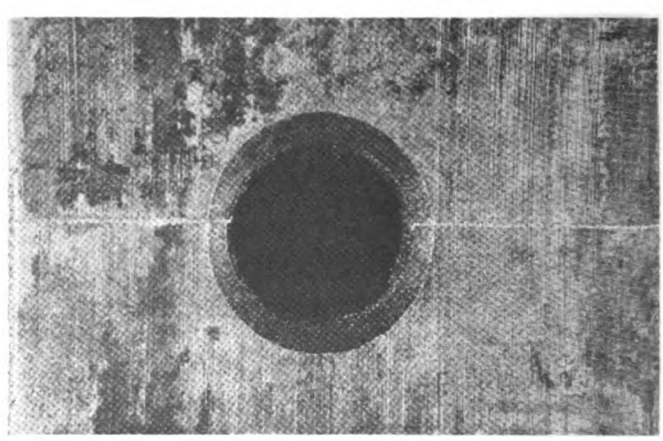
The stationary unit is built of heavy, structural-steel shapes entirely welded together and strong enough to support axle loads of 3,000 lb. The auxiliary equipment consists of two large structural-steel horses used to support from four to six side rods or other locomotive parts. The unit is alternating-current operated and



One of the fixed units testing axles in the shop

capable of delivering a maximum of 5,000 amp. at 20 volts.

Cables used on both types of equipment for rod testing are No. 0000 extra-flexible stranded copper cables.



Here is a crack through the grease hole of a locomotive rod

In order to lengthen the life of these cables the railroad has had them rubber-covered.

In order to permit the proper inspection of any parts under test, it is necessary to have the material cleaned of oil and grease and to have all the non-ferrous parts, such as brass bushings, collars, etc. removed. A perfectly bright, clean surface is not necessary as the powder will reveal the cracks through scale or rust.

The organization for handling the inspection consists of operators stationed at Salt Lake City, Grand Junction,

* Engineer of Tests.

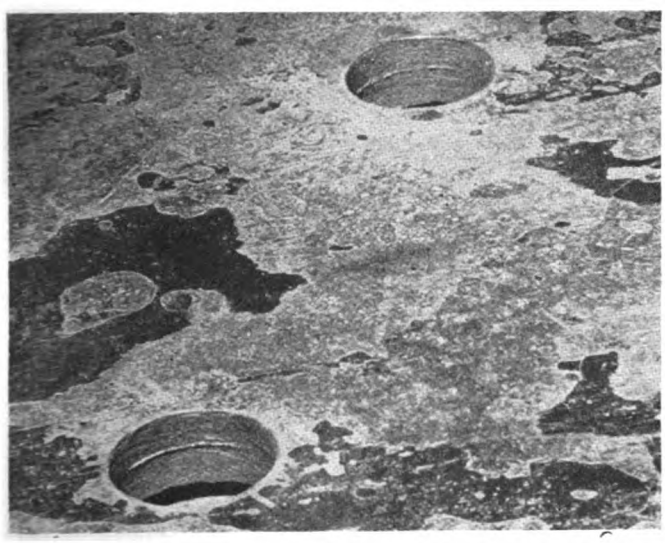
and Denver. These men are electrical engineers capable of investigating and designing such new equipment as may be found advantageous, and work under the supervision of the engineer of tests.

Parts inspected, so far as locomotives are concerned, are handled in the back shop, the drop pit in the enginehouse, and the wheel shop. Also new castings are inspected upon arrival at the stores department or in the shops. The following are typical of the parts inspected: rods, eccentric cranks, crossheads, drawbars, hangers, levers, links, pins, plates, axles, springs, stems, wheels and yokes.

At the drop pit, the portable unit is used to test rods, valve-motion parts, crank pins, etc. which are removed from the locomotives. In the enginehouse, motion work such as rods and any other parts which it is desired to test are tested on the locomotives. In the back shop, practically all dismantled material from locomotives is tested using either the portable or the fixed unit. New forgings and castings are also tested.

Since Magnaflux inspection was installed, a total of 7,039 parts had been tested up to March 1, 1938, and of these, 1,533 had been found defective.

A report of the Magnaflux inspection is made daily on a form, showing the locomotive number, name of part



Laminations can be detected in boiler sheets through drilled holes and Magnaflux inspection

tested, nature and location of defect and the disposition of the part.

The testing unit is simply a device to lower the electric voltage and increase the current, and by means of a few turns of cable any desired amount of ampere turns can be secured. From observation on the railroad, from 500 to 2,000 amp. turns are generally found sufficient. In the set-up, the cable is wrapped directly around the parts to be tested and the part laid at right angles to the magnetic flow. This is a means of locating transverse cracks in locomotive side or main rods. In order to locate longitudinal defects, a heavy current of about 1,500 amp. is passed directly through the piece instantaneously, in which case the magnetization is circular. This method is especially advantageous for axles in routine testing, or for small tools where the defects or flaws are in the direction of the current flow. The magnetic powder can be applied wet or dry, as convenient, and either method is effective. On the D. & R. G. W. dry powder is used exclusively.

Compared with the old method of testing by whiting, this non-destructive method of testing has several positive advantages. In the first place, it is much more rapid as the magnetization is practically instantaneous and any number of pieces can be tested in a relatively short time. In the second place, an important advantage is that minute fatigue cracks and cracks which are in compression can be instantaneously discovered, but with the old whiting method, most defects of this kind were missed. Scale, which might be present, does not interfere with the inspection.

The accomplishments on the D. & R. G. W. by this method of inspection have been: (1) A substantial reduction in service failures by the detection of surface fatigue cracks in the material in service; (2) the prevention of failures by the detection of manufacturer's defects present in new forgings and castings; (3) the prevention of failures and saving of material by the location of small surface-fatigue cracks just originating or developing and grinding them out, thus preventing loss of material through failure; (4) the systematic checking of ferrous parts at terminals; (5) the study of the origin of fatigue defects and effecting a remedy by changing either design, manufacture, or service conditions, and (6) a close co-ordination of testing both service and material failures with the mechanical department which has resulted in substantial improvement in quality of material and in the reduction of road and service failures.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

The Strength of Pitted Plates

Q.—Can you give an example of how a certified boiler inspector would set the factor of safety and the allowed safe working pressure on an old boiler that is over 30 years old, in which the comparison of the deterioration of the metal along the seams and the entire structure is involved?—C. M. C.

A.—The author is unable to give an illustration of a certified boiler-inspector's report, but the following information in regard to this question might be of some assistance:

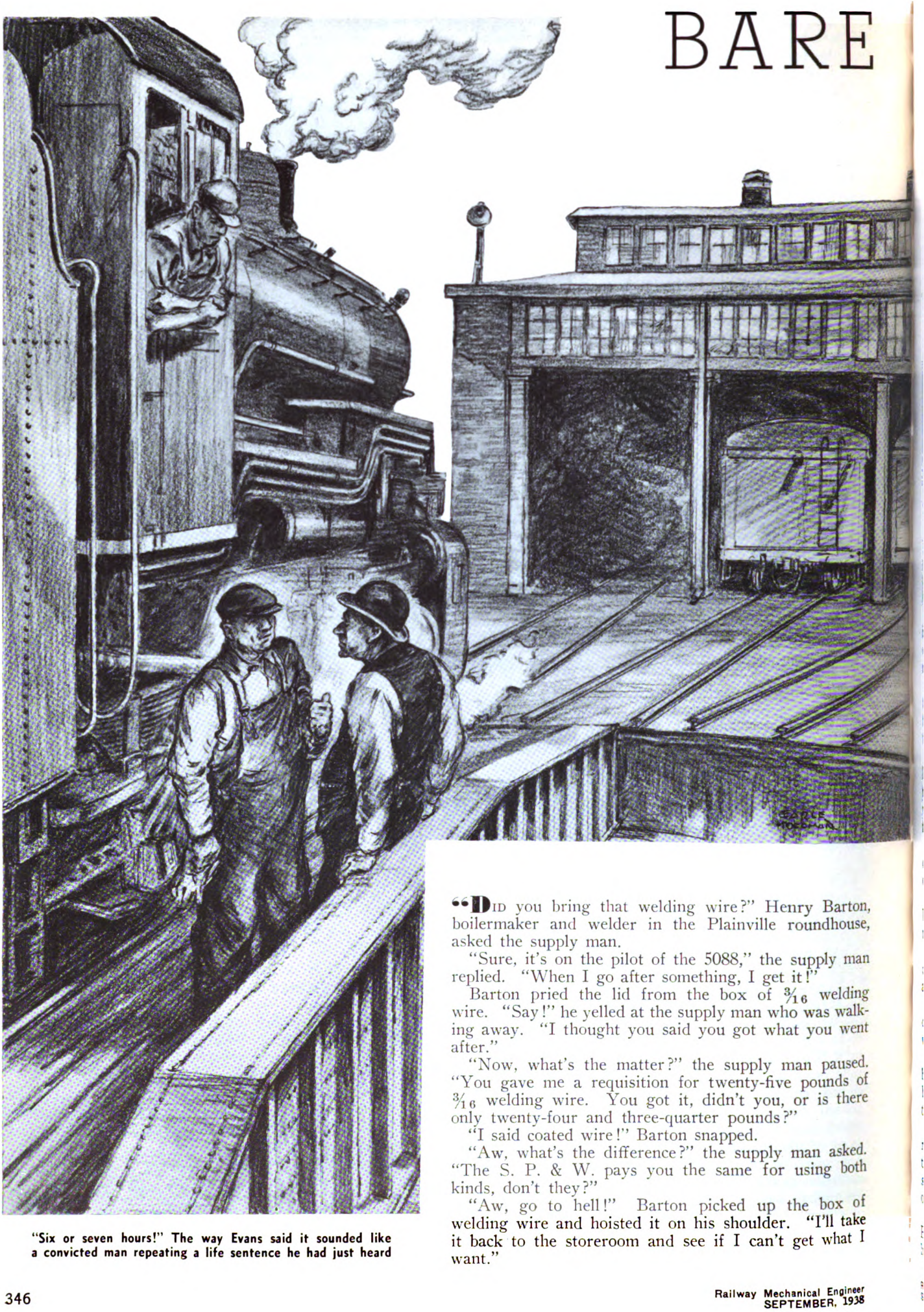
The I. C. C. ruling regarding the factor of safety is as follows: "Rule 2. The lowest factor of safety for locomotive boilers, which were in service or under construction prior to January 1, 1912, shall be 3.25. Effective October 1, 1919, the lowest factor of safety shall be 3.5. Effective January 1, 1921, the lowest factor of safety shall be 3.75. Effective January 1, 1923, the lowest factor of safety shall be 4."

The following example is a good illustration of determining the effect of pitting in a sheet:

If the shell is extensively pitted—for instance, when measured longitudinally through the pitted areas and the pitted section is near or exceeds the measurement of

(Continued on page 349)

BARE



"Six or seven hours!" The way Evans said it sounded like a convicted man repeating a life sentence he had just heard

"DID you bring that welding wire?" Henry Barton, boilermaker and welder in the Plainville roundhouse, asked the supply man.

"Sure, it's on the pilot of the 5088," the supply man replied. "When I go after something, I get it!"

Barton pried the lid from the box of $\frac{3}{16}$ welding wire. "Say!" he yelled at the supply man who was walking away. "I thought you said you got what you went after."

"Now, what's the matter?" the supply man paused. "You gave me a requisition for twenty-five pounds of $\frac{3}{16}$ welding wire. You got it, didn't you, or is there only twenty-four and three-quarter pounds?"

"I said coated wire!" Barton snapped.

"Aw, what's the difference?" the supply man asked. "The S. P. & W. pays you the same for using both kinds, don't they?"

"Aw, go to hell!" Barton picked up the box of welding wire and hoisted it on his shoulder. "I'll take it back to the storeroom and see if I can't get what I want."

FACTS

by

Walt Wyre

• • •

"Say," Barton yelled, at the same time dropping the box of welding wire on the metal covered counter in the storeroom.

"Now what's eating you?" the storekeeper asked, walking towards the counter. "What's the idea of making so much noise?"

"I sent a requisition for coated welding wire and this is what you send me." The boilermaker pointed at the box on the counter.

"Haven't got any coated wire," the storekeeper said. "I ordered it, but that is what they sent. You'll have to use it."

"What's the matter, the S. P. & W. going broke?" Barton asked sarcastically.

"They would be if the store department bought everything the mechanical department wanted," the storekeeper replied. "Like this welding wire, for instance; the coated wire costs nearly twice as much as the bare wire."

"Yeah," Barton picked up the box of wire, "I'll bet if the store department had to use it they would be a durned sight more particular about the quality of the material they furnish."

When Barton got back to the roundhouse, Jim Evans, the foreman, was waiting at the door. "I'm in a hurry for the 5088," Evans said. "How are you coming on that crack in the fire-box?"

"I've got it all chipped out. That took a lot of time because it had been welded before and I had to chip out the old weld. If we could get the right kind of wire we wouldn't have so much trouble with welds in the fire-box giving way," Barton added.

"Well, get the 5088 finished soon as you can so we can get a fire in her. I'm expecting a call at any time on her."

The foreman went on through the roundhouse. Barton, still carrying the box of welding wire, went to the 5088 and climbed up in the cab.

The boilermaker's helper had strung out the welder cables and was waiting in the cab. "Going to need all of that wire on this job?" Barton's helper asked.

"Hell, no," the boilermaker replied. "But I don't care if you take what's left and dump it in the hot well after I get through."

When the foreman was about half through the roundhouse he met machinist Jenkins. "Say, Mr. Evans, how about getting the knuckle pin dowels welded on the 5076?"

"Both welders are tied up right now," the foreman replied. "Barton is on a hot shot job in the fire-box of the 5088 and Walters is building up driving boxes. We sure need another machine here. There sure is a lot of welding to be done."

The machinist stood hesitatingly for a moment, then Evans said, "Tell Barton I said to weld the dowels when he finishes the 5088."

THE foreman, eight hours late and two engines short, as usual, went on through the house and to the office hoping the dispatcher wouldn't call for an engine in the next couple of hours.

Evans sat down at his desk in the office and bit off a morsel of "horseshoe." His body was relaxed but his mind wasn't. He was thinking of work needed on the various locomotives assigned to the Plains Division.

The 5072 needed a new set of tires, the 5084 was overdue classified repairs, driving boxes were pounding, pins worn, and so on down the line. One needed this and the other needed that. Only a few were in good condition.

While he was thinking, the 5090 rolled in on the lead. She had just come in on a fast freight. "That's a good engine," Evans thought, and he mentally marked the 5090 for the Limited. The 5000-Class locomotives are used by the S. P. & W. for both fast freight and heavy passenger service.

Through the window the foreman watched the engineer walk around the engine feeling of bearings to see if any were hot. Something in the hoghead's actions didn't look just right to Evans. The foreman rose and walked out to the engine.

"Well, how did you make it?" Evans inquired.

"Like to not made it at all," the hoghead said peevishly.

"Run hot?"

"Naw, just the opposite," the engineer growled. "Couldn't keep steam, bad leak in the fire-box. If she was a coal burner, it would have put the fire out." The engineer shouldered his tin suitcase and started to the wash room.

Evans climbed up in the cab and opened the fire-box door. The fire-box was so full of steam he couldn't tell much about it. The leak appeared to be somewhere in the front end of the fire-box.

While he was in the cab the hostler came to take the engine around.

"Get her in the house soon as you can," the foreman told the hostler. "There's a bad leak in the fire-box. I want to get her blown down and repaired."

Barton finished welding the crack in the fire-box of the 5088, then welded the knuckle pin dowels for the machinist. When he had finished, he and his helper dragged the welder down to the other end of the house to the 5078.

Barton's helper was stringing out the cables and Barton was climbing up in the cab to go in the fire-box when the foreman came up.

"What have you got on her?" the foreman asked.

"Not much," Barton replied. "Some leaks in the flue sheets around the flues."

"Well, get them and as soon as the 5090 is blown down, see where all the leak in the fire-box is. I've got to use her tonight if there's any possible chance."

When Barton began examining the interior of the fire-box he found conditions worse than he had anticipated. All of the cracks were small, but there were many of them. A majority of the leaks were in old welds.

"We'll have to have a gun chisel," Barton told his helper. "You get an air hose connected up and I'll get the air hammer and chisel."

The boilermaker set to work chipping out the cracks so that the new weld would have good clean metal to adhere to.

Rat-tat-tat!—the noise in the fire-box was deafening, but the boilermaker, accustomed to it, didn't seem to mind. Metal chips flew as Barton veed out the cracks.

Evans passed by the locomotive and heard the air hammer going like a machine gun in the distance. Thirty minutes later the foreman passed again and the boiler-

maker was still chipping. Evans was beginning to be anxious and walked back to the cab to see how long it was going to take the boilermaker to finish.

"Hey!" Evans yelled in the fire-box door, then yelled again louder.

Barton, air gun in hand, turned towards the fire-box door.

"I thought there wasn't much to do in this one," Evans said. "From the way it sounds you've already cut out more than you'll get welded today."

"It's worse than I thought," Barton replied. "Nearly all of the cracks are old welds that have given away."

"Looks like we are having too much trouble with welds not holding," the foreman observed.

"That's right," Barton agreed, "and it's mostly because we're using the cheapest welding wire that the stores department can buy."

"I told the storekeeper to order coated wire," Evans said. "Didn't he get it?"

"Naw," the boilermaker laid the air hammer down and picked up several lengths of the welding wire he was using. He walked to the door. "Here's what we are getting and it's not worth a damn! It might have been O.K. ten or fifteen years ago," Barton said, "but they've got lots better than this now. The better grades of coated wire have nearly twice the strength and are lot faster to use."

The foreman took the lengths of welding wire. "How long is it going to take to finish this one?"

"Over an hour," Barton replied, "and then I'll just get the worst places. I'm just about through chipping," he added.

EVANS climbed down and went to the storeroom carrying the pieces of welding wire. "Say, why can't we get the kind of material we order?" the foreman asked the storekeeper.

"Don't know; what is it you didn't get?"

"Well, for one thing, why can't we get the right kind of welding wire? The welders claim that this bare wire is as out of date as wood burning locomotives and about as efficient."

"Aw, they just want something to bellyache about," the storekeeper said. "If it wasn't welding wire, it would be something else! Just like the machinists, they beefed about the steel we were getting for machine tools until we got the kind they wanted and now they want something different. This is the same kind of welding wire we've been getting for the past five years."

"That's the trouble," Evans observed. "By the time the stores department gets around to buying anything new, there's been an improvement made."

"O.K.," the storekeeper said as though he were just agreeing with the foreman to humor him. "I'll order coated wire again, but I doubt if we get it. It costs nearly twice as much and the purchasing department is trying to save the company money. They don't like to pay a fancy price for a lot of beet pulp stuck on welding wire just because it strikes the fancy of the mechanical department," the storekeeper added in what he intended to be a joking manner.

Barton finished in the fire-box, then leaving his helper to gather up the tools and wind up the welder cables, he went down to the 5090.

The leak was around the middle siphon collar and it was bad. It was another case of a weld having given away. Contraction and expansion from heat variation and strains from the weaving of the boiler had started a crack in the weakest place. The weakest place happened to be in the weld. Perhaps the welder in a rush to finish had grown a little careless and left a weak place in the weld. Perhaps even if the best grade of coated wire had been used instead of bare wire the weld would have failed, but not likely. The extra strength of the better wire would have lessened the chances for failure a lot.

Evans returned from the storeroom and went through the roundhouse to see how things were going. When he passed the drop-pit, machinist Jenkins stopped him.

"We're ready to cut the valve bushing out of the 5074," the machinist said.

Electric welders using a carbon arc are used at Plainville for cutting out valve bushings. Both welders were busy as section men when the superintendent's inspection car passed.

Evans scratched his head a moment, then said, "Just have to let the bushings go for the time being. Wish we had another welder," he added as he walked away.

The familiar rat-tat-tat in the fire-box of the 5090 told the foreman that Barton was beginning to work on her. He went over to see how much of a job it was going to be.

"What did you find?" Evans asked.

"Pretty bad," Barton replied. "It really should have a new plate welded in, but guess I can get by with chipping it out and welding."

"How long will it take?"

"I won't be able to get it finished before five o'clock," the boilermaker said.

"Can you finish by seven o'clock?"

"Yeah, I think so."

"Well, stay and finish it. I've got to have that locomotive."

More overtime to be explained, Evans thought as he walked to the office. Next to an engine failure, overtime was the hardest to explain satisfactorily.

Things went along fairly well for the next several days. Thinking of other things, Evans had almost forgotten about welding wire.

Barton had decided that trying to get the S. P. & W. to use coated wire was wasted effort, said no more about it, and did the best he could with the wire he had. He was, however, chronically behind with his welding as was the machinist welder.

THEN the 5085 came in with a broken frame.

A sudden spurt of business as sometimes happens even now on the railroad left Evans hard pressed for locomotives. Every engine that was in condition to run at all, and some that weren't, was run.

The foreman was in the roundhouse marking up the board when the roundhouse clerk found him. "The dispatcher says he'll want an engine for an extra fruit train about six-thirty," the clerk told the foreman.

Evans looked at his watch. It was twenty minutes until two. Evans though a moment. "We haven't got anything but the 5085 that just came in. It got here, it should be able to go again."

"O.K., I'll tell him." The clerk went back to the office.

The inspector was at the same time looking over the 5085 out on the inspection pit. He had written down only a few items of minor consequence when he saw the broken frame. He stooped closer to look, but didn't need to get very close to see the break. He marked on each side of the break with a piece of light blue crayon and continued to look for further defects.

"Don't find too much on her; I'm going to have to run her east about six o'clock," Evans came up and said to the inspector.

"Well, I haven't found much but a broken frame."

Evans almost lost his temper when the inspector

grinned. Then he thought perhaps the inspector was joking. "Where's any broken frame?"

"Right here, and it's in a mean place to weld, too."

"Tell the hostler to get her in the house right away." The foreman turned and headed for the roundhouse almost at a run. He found Barton and told him about the broken frame. "How long do you think it will take to weld it with you and the machinist welder both working on it?"

"Depends on where the break is. I'd have to look at it first."

The hostler had the 5085 on the turntable preparing to put it in the house. Evans and the boilermaker went out to look at the broken frame.

"How long will it take?" the foreman asked anxiously.

"It's in a pretty bad place," Barton said. "Two welders couldn't work on it very well at the same time."

"How long will it take the best you can do?" Evans asked again. "I've got to have an engine and this is the only one left."

"Six or seven hours, I'd say if I have good luck. It'll take some time to vee it out and get ready to weld."

"Six or seven hours!" The way Evans said it sounded like a convicted man repeating a life sentence he had just heard.

"Well, I could do a lot better if I had some quarter-inch coated wire."

"How much better?"

"Oh, I could cut the actual welding time in half. It would take just as long to get it ready, though."

"Well, start getting it ready." Evans spun on his heel and headed for the storeroom like a boy with a nickel going after candy.

Barton's helper brought a cutting torch and rig down to the engine. The boilermaker lighted the torch and pulled a pair of goggles over his eyes.

"You might get the welder down here and string out the cables," Barton told the helper. "No rush, though. You'll have plenty of time while I vee out the crack."

"Did you get that welding wire?" Evans asked as he entered the storeroom.

"Sure thing," the storekeeper replied. "It's in the rack."

The foreman opened the gate and walked back to the rack where the welding wire was stored. He located a box of quarter-inch welding wire. Using a chisel, he opened the box.

"That what you are looking for?" the storekeeper inquired casually.

"Hell, no!" Evans snapped. "This is just like you've been getting all the time."

"It's what they sent," the storekeeper said, "and I guess you'll have to use it."

Evans picked up a length of the wire and looked at it a moment. "Say, do you suppose one of the welding shops up town would have some coated wire?" he asked suddenly.

"They might have," the storekeeper replied. "Why?"

Thought I might trade them some of this. I'm going and see."

The foreman left the storeroom and returned a few minutes later in his car. He loaded two boxes of the quarter-inch bare wire.

"Come go with me," Evans said to the storekeeper.

On the way up town Evans explained the situation to the storekeeper.

"Yeah, we've got lots of coated wire," the owner of the contract welding shop said. "How much do you want?"

"I wanted to trade you some bare wire," Evans explained.

"I couldn't use bare wire at any price," the welder replied. "Even if you gave it to me, it would be too expensive on most jobs."

"Well, I guess that's that," the storekeeper said and started to the car.

"Like hell it is! We're going to buy some wire!"

"But I can't explain——" the storekeeper started to say when Evans interrupted.

"I'll do the explaining, all you have to do is pay for the wire. I believe I can explain it so that the next time the purchasing department buys welding wire they'll get the kind we want."

When Evans reached the roundhouse, Barton had the crack just about ready to start welding. Evans dumped the box of coated wire down beside the pit.

Barton shut off the torch and lifted his goggles. "That's more like it!" he said. "With two of us taking turns, we'll have this frame welded before you know it. But we won't get the overtime I was figuring on," he added.

Locomotive Boiler Questions and Answers

(*Continued from page 345*)

the outer pitch of the longitudinal seam—determine the decrease in tensile strength of the plate that has deteriorated through the net section on a line between the two extreme pits, inclusive.

Assuming that all the pit holes in that line are deteriorated the worst, determine the result by the following calculations: First determine the factor of safety of the boiler by the formula:

$$FS = \frac{TS \times T \times e}{R \times P}$$

where TS = tensile strength of the boiler shell plate, lb. per sq. in.; T = thickness of shell plate, in.; e = efficiency of the longitudinal seam, expressed as a decimal; R = radius of largest shell course, in.; FS = factor of safety; and P = working steam pressure, lb. per sq. in. As an example, if TS = 55,000 lb. per sq. in., T = 0.75 in., e = 0.86, R = 42 in. and P = 200 lb. per sq. in., then

$$FS = \frac{55{,}000 \times 0.75 \times 0.86}{42 \times 200} = 4.22.$$

Having determined the actual factor of safety of the boiler, determine the strengths by the following formula and example:

Let A-A = the section of the sheet between the extreme pits
TS = tensile strength of boiler plate, lb. per sq. in.
T = thickness of the plate, in.
B = approximate depth of pits, in.
C = distance between extreme pits or *A* – *A*, inclusive, in.
D = tensile strength of solid shell plate between *A* – *A*, inclusive, lb.
= T × C × TS
E = sum of diameters of all pits between A – A, inclusive, in.
F = tensile strength of shell plate that has deteriorated away through the net section between A – A, inclusive, lb.
= B × E × TS.
G = tensile strength of the remaining net section of the plate between A – A after deducting the tensile strength of the plate that has deteriorated between A – A, inclusive, lb.
= D – F.

Assume, for this problem, that T = 0.75 in., as before, C = 20 in., TS = 55,000 lb. per sq. in., B = 0.1875 in., and E = 8.5 in. Then $D = T \times C \times TS$ = 0.75 × 20 × 55,000 = 825,000 lb.; $F = B \times E \times$

$TS = 0.1875 \times 8.5 \times 55{,}000 = 87{,}656$ lb.; and $G = D - F = 825{,}000 - 87{,}656 = 737{,}344$ lb.

The tensile strength required by the factor of safety established by law can be calculated from the formula:

$$SR = (TS/FS)\ RFS \times T \times C$$

where RFS = required factor of safety by law = 4; SR = tensile strength required for RFS; TS = tensile strength of the plate, lb. per sq. in.; T = thickness of the plate, in. as before; and C = the distance between the extreme pits, inclusive, as before. Continuing with the values previously given, the tensile strength required for the factor of safety established required by law, using the last given equation, is

$$(55{,}000/4.22) \times 4 \times 0.75 \times 20 = 781{,}984 \text{ lb.}$$

It is seen in the example taken, that G is (781,980 — 737,344) 44,636 lb. less than SR; therefore, the tensile strength of the deteriorated plate falls short of that required, which shows that from a trifle more than $1\frac{9}{16}$ sq. in. of deteriorated net section of plate in this example, about (44,636/55,000) $1\frac{3}{16}$ sq. in. of the net section of shell plate between A — A, inclusive, has deteriorated beyond the limit requiring a tensile strength equivalent to that for a factor of safety of four by law.

Automatic Thread-Grinding Machine

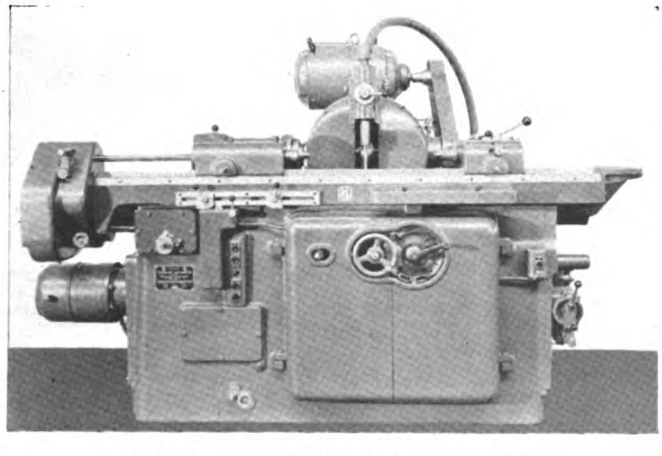
The Jones & Lamson Machine Company, Springfield, Vt., is manufacturing an automatic thread-grinding machine, which is designed to grind threads in hard or soft material on work up to 8 in. in diameter when using a 20-in. grinding wheel. Work 48-in. long may be held between centers, and 18 in. of thread may be ground anywhere on 36 in. of work length. Work 11½ in. in diameter may be swung over the work slide and 11½ in. diameter threads may be ground when the wheel is 16½ in. in diameter, or smaller. A 20-in. diameter grinding wheel is furnished as standard, and, as the wheel decreases in size, the proper peripheral speed may be retained through rheostat control of the wheel motor. The helix angle capacity of the new machine has been increased to include 25 deg. right hand and 30 deg. left hand. The helix angle is changed by a worm and gear.

Standard equipment includes change gears for pitches from 2 to 48, inclusive. The machine will grind single, double, triple, quadruple and sextuple threads, either right or left hand. Using a simple hardened and ground former, it will grind taper, combination of straight and taper, or double taper threads. Accurate reproduction of taper is assured. The grinding wheel is always at right angles to the axis of the work; therefore, no adjustment of thread form is required when changing from straight to taper threads, and the J. & L. method of grinding taper threads makes lead compensations unnecessary.

This machine, with the necessary attachments, will grind button-type hobs and circular chasers without lead; also, it will back off, or relieve, straight or taper hobs or taps with either straight or spiral flutes. A standard attachment may also be furnished for grinding interrupted threads on straight- or spiral-fluted taps.

A direct-current motor is recommended for driving the grinding wheel. One of the most important features is the provision made for running all types of grinding wheels at efficient work speeds. This is accomplished by a scale attached to the truing device for recording the wheel diameter at all times and a graduated rheostat with pointer indicating the spindle revolutions. A chart on the wheel slide shows the number of surface feet the wheel is running, based on the wheel diameter and spindle revolutions. As the wheel is reduced in diameter, the proper speed is maintained by simply turning the dial on the rheostat. While it is possible to furnish an alternating-current motor for driving the wheel, the company discourages the practice. Either alternating-current or direct-current motors can be furnished for the wheel-truing device, coolant pump and machine operations.

The self-truing, self-sizing mechanism of this machine brings thread grinding into the range of practical shop operations. It is suited equally well to tool-room and production work.

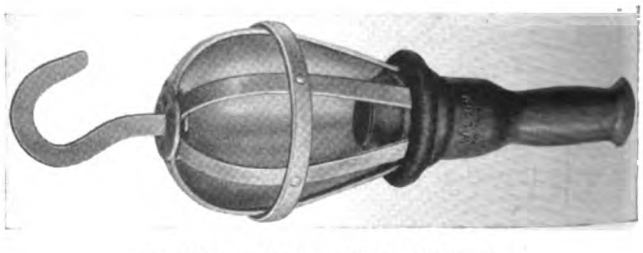


J. & L. automatic thread-grinding machine

Screwless Shock-Proof Fiber Lamp Guard

The illustration shows a screwless shock-proof lamp guard made of fiber with a heavy flexible rubber handle and rubber locking ring, the latter of which holds the fiber guard without the use of screws. The guard is made of flexible vulcanized fiber and is comprised of strips, a ring, a hook, and a reflector. The hook can be swiveled to hold the guard in any position. The rubber handle and rubber locking ring are made of 50 per cent pure vulcanized rubber and are designed to withstand a temperature of 350 deg. F.

The feature of this lamp is the means used for locking the fiber guard to the rubber handle. The solid rubber ring at the top of the handle is the only means used for holding the guard in place. When it is necessary to replace a globe this ring is rolled back along the handle and the fiber guard lifted out of place. The Safe Guard Electric Company, Inc., Brooklyn, New York, manufactures this device, which is known as the Wilson screwless shock-proof fiber guard.



The Wilson shock-proof fiber light guard

With the Car Foremen and Inspectors



Train of 100 newly built wagon-top box cars leaving DuBois, Pa., en route to Pittsburgh

B. & O. Builds 2,000 Wagon-Top Box Cars

In June, 1937, the Baltimore & Ohio started the construction of 2,000 new wagon-top box cars, to be known as class M-53, all of which were completed by March, 1938. The design of these cars was first adopted in 1935 when the B. & O. built 13 experimental cars of various types, including five of the wagon-top design, using lightweight high-tensile alloys in their construction. Having demonstrated, through service test, the practicability of the wagon-top design, it was used in 1936 and 1937 when 1,300 box cars were scheduled for rebuilding. These were cars with wooden bodies on steel underframes of the fishbelly type, the underframes and trucks being still in serviceable condition, but on which the top had to be entirely replaced. New all-steel bodies of the improved wagon-top design were installed, thereby increasing the cubic capacity of these cars by 32.7 per cent over the original design with wooden body.

When the order for the new 2,000 car lot of wagon-top

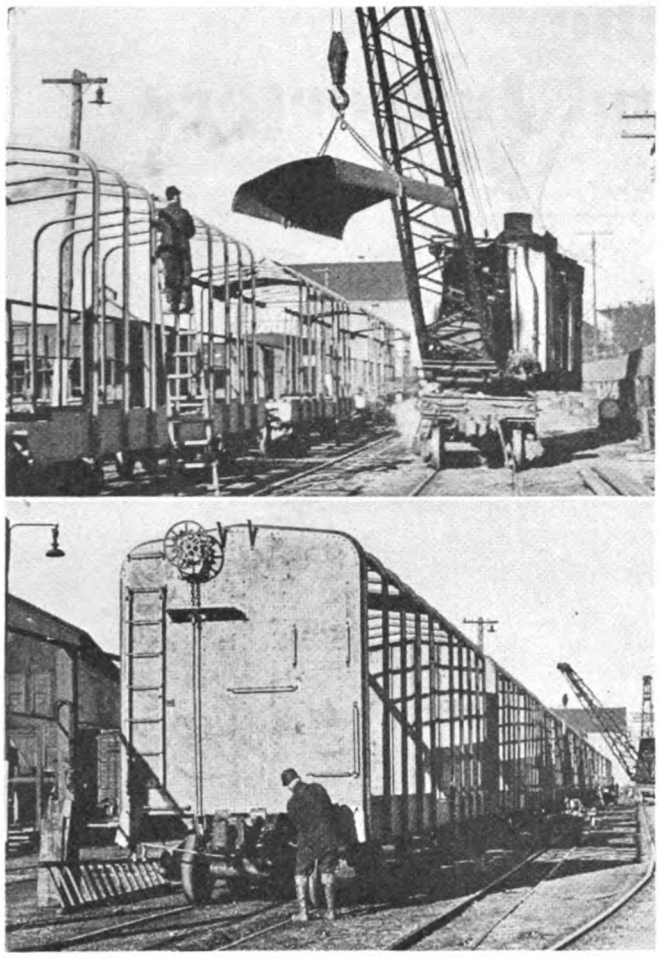
Comparison of General Dimensions and Weights of B. & O. Class M-26e and Class M-53 Box Cars*

Class	M-26e	M-53
Light weight of car, lb.	48,100	46,500
Load limit (revenue load), lb.	120,900	122,500
Ratio of payload to gross load	0.715	0.725
Capacity, cu. ft.	3,056	3,712
Inside length, ft. and in.	40-6	40- 6
Inside width, ft. and in.	8-9⅛	9- 2
Inside height, ft. and in.	8-7⅜	10- 0
Width at eaves, ft. and in.	....	9-10
Height at eaves, ft. and in.	....	12- 7
Length of car in train, ft. and in.	45-4	45- 0½

* Both of these types have 5½-in. by 10-in. journals and Duryea underframes.



M-53 wagon-top box cars being built by the progressive spot system at DuBois, Pa.

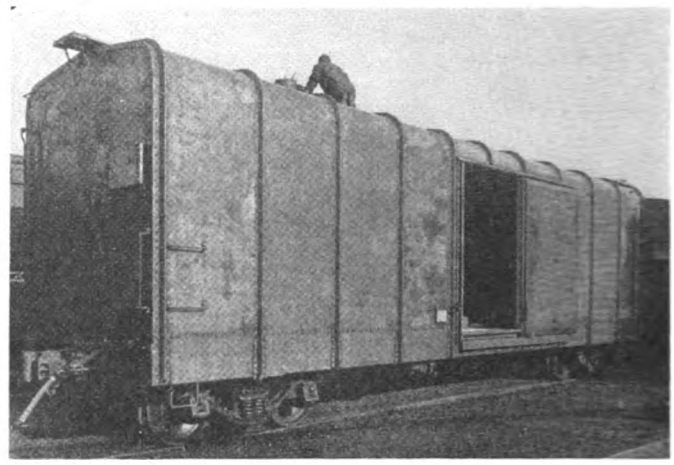


Top: Swinging the portion of the roof sheet over the doorway into place on M-53 box car—Bottom: The end of the car in place, but without side sheets applied

cars was placed, construction was distributed among various B. & O. shops as follows: 675 were built at Keyser, W. Va.; 575 at DuBois, Pa.; 385 at Chillicothe, Ohio; and 365 at Washington, Ind. All the cars were built by the progressive spot system, and it was found that the simplicity of their design and construction made it possible for a unit of 50 men to erect and complete two and one-half cars per working day of eight hours.

The underframes and trucks were built by the Bethlehem Steel Company and shipped complete to the various shops. The underframe is the Duryea cushion type, made of copper-bearing steel, in which the center sills are subjected to end loads or buffing shocks only, and are not a part of the car structure; they do not carry any weight of the body or super-imposed load. The B. & O. has found this type of underframe satisfactory in service and now has 14,000 cars in service equipped with them.

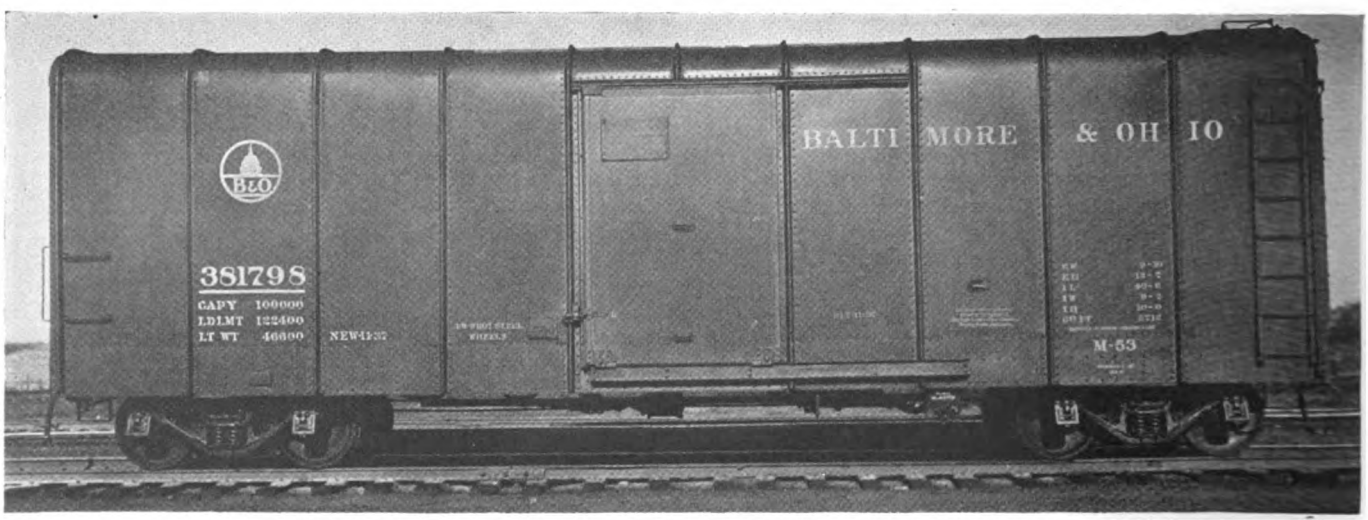
The trucks are made of grade B steel, with 5½-in. by 10-in. journals and integral-box side frames. The truck bolsters are equipped with roller-type side bearings.



Completed car ready for painting

No. 15 Buffalo and Damascus brake beams, and Schaefer truck connections are used. The trucks are also equipped with one-wear wrought-steel wheels and grooved journal bearings to trap waste grabs. Orders for the integral-box side frames and bolsters were distributed among the Buckeye Steel Castings Company, American Steel Foundries, Ohio Steel Foundry Company, Gould Coupler Company and the Pittsburgh Steel Foundry Corporation. All journal bearings were provided by the National Bearing Metals Corporation.

The body superstructure is the most interesting feature of this type of car, because of its radical departure from previous car designs. The superstructure is formed of combination side post and roof carline in one piece, extending up one side of the car, across the top, and down the opposite side. They are formed with a large radius at the eaves and drain slope from the center of the



B. & O. wagon-top box car of 3,712 cu. ft. capacity

roof. Riveted to them at the eaves, on the inside of the car, is a longitudinal side plate of the same shape as the side posts. These combination side posts and roof carlines were formed in their familiar U shape at the bolt and forge shop of the B. & O. at Cumberland, Md., on a machine especially designed for the purpose. Shipped to the various shops, ready to install, they were easily lifted into place by a crane and riveted to the side sills of the car.

The side sheets, made of copper-bearing steels, were fabricated at the Cumberland bolt-and-forge shop and shipped to the various shops ready for installation. These combination side-and-roof sheets, which are 3/32 in. thick and which extend from the side sills to the center of the top, or ridge, of the car, are joined at that point by a waterproof riveted lap joint. Each sheet when applied is fastened first at the sides and then bent over to form the roof, making a continuous sheet from the side sill to the center of the roof. The sheets are riveted to the outside face of the flanges of the combination side posts and roof carlines, making it impossible for driving rains to hit the edges of the sheet and force its way into the car, the edges being protected by the channels of the frame members.

The ends of the cars were fabricated at Cumberland, each made from a single sheet of 3/16-in. copper-bearing steel, stiffened by vertical posts. They are flanged and riveted to the end combination side post and carline flange.

The side doors, also fabricated at Cumberland, are made of a single sheet of steel, designed with two horizontal stiffeners on the inside. The bottom hangers are of the roller type mounted in steel castings and rolled on the flange of a 6-in. channel door track. Depressions formed in the door track assist in holding the door either in its open or closed position, and insure that the weight of the door is off the rollers when it is closed.

The interiors of these cars are lined with wood, except the ceiling. The floor is 1¾ in. thick and the side planking is 13/16 in. thick. Nailing posts are imbedded in the hollows of the side-post channels, and their locations are marked with a black stripe on the face of the inside lining. Shippers are requested, by stencilled instructions in the car, to do their cleating and nailing at the places so designated.

These cars are equipped with Barber lateral-motion device, Type E automatic couplers which are operated by the Imperial rotary coupler release rigging, AB automatic air brakes, Ajax hand brakes, and improved side and end ladders which can readily be removed in transportation yards for repairs without requiring the car to be sent to the shop track.

The actual construction of the cars varied slightly at the various shops, depending on facilities available for handling the one-piece combination side posts and roof carlines, the side sheets, roof sheets over the doors, the ends and the doors. As shown in several of the illustrations a locomotive crane was used for this work, although at Keyser, W. Va., a gantry crane was employed. The trucks and underframes as received from the Bethlehem Steel Company were assembled at one end of the line, outside the shop and moved progressively for applying the side posts and carlines, ends, side sheets and doors. Interior work and finishing was done inside the shops, after which the cars were sent to the paint track for completing.

The table shows a comparison between a B. & O. box car of the conventional type, class M-26e, and the new car, class M-53. The points emphasized by the railroad in favor of the new design are lower maintenance cost, fewer parts, fewer joints where water may enter than in any other type of all-steel box car, and relative freedom from rolling insured by the lightness of the superstructure and low center of gravity. It is necessary to carry but few parts at repair shops to take care of the class M-53 cars, the only parts needed for the superstructure being the combination side and roof sheet and the combination side post and roof carline. The B. & O. is using cars of this type exclusively in trains Nos. 117 and 118, fast overnight merchandise freight trains operating between Pittsburgh and New York. Shippers are requesting them for loading and their popularity is said to be increasing daily.

Loss and Damage And the Car Man*

By Joe Marshall

Whenever opportunity offers, I always suggest that the various car foremen's associations exchange information. The car men located in large terminals accumulate information of great value to the car men at the smaller loading points and terminals throughout the land. If a plan of this nature is not practical, there is another way to do it—tabulate information of value and pass it along with your suggestions to the freight claim conference in your district—they have almost direct contact with every loading point in the United States and Canada. Intermediate inspection points should take on the responsibility of catching loads originating at smaller points and promptly advising such points of all failures and how to avoid them.

You gentlemen know about the plan in effect for some years in Chicago Terminal district, under which all defects are tabulated and defective parts held for inspection and every possible effort made to repair cars in time for scheduled movement. I charted their 1937 report covering perishable traffic only. These figures show the changed conditions during the past ten years or so when light couplers, spring draft gears and related parts were responsible for the greater portion of our bad-order transfers. This chart shows the high spots to be wheels, 53.3 per cent; brake beams and attachments, 10.7 per cent; axles and cut journals, 9.4 per cent; journal boxes and column bolts, 6.9 per cent; truck springs, 5.2 per cent; inoperative air brakes, 3.8 per cent; spring planks, 3.6 per cent; and couplers and parts, 2.4 per cent.

Observations on Special Equipment

Auto device cars are an expensive addition to our special equipment and they become much more expensive when, through lack of ordinary care in replacing the racks after unloading, they fail under the next load and create damage to automobiles loaded therein.

One of the indoor sports of the trade has been that of panning the refrigerator car, based not on the millions of loads which carry safely, but upon a comparatively few failures due mostly to inexperience and abuse plus failure to capitalize the results seen at destination.

There is one serious defect worthy of study. This refers to hatch covers open for ventilation and jarred closed by vibration. A mechanical man ought to find no problem in devising a method for holding the hatch cover in open position during the movement of the car. You can think about the refrigerator car by noting the

* Excerpts from a paper presented by Joe Marshall, special representative, A. A. R. Freight Claim Division before the St. Louis Car Department Association at a meeting held at St. Louis, Mo., May 17, 1938.

causes for damage as recorded by your claim department and which you can help correct. There are 12 different items in the fresh fruit and vegetable group which cost from $10 to $21 per car in damage for every trip. One company equipped 20 cars with a longitudinal floor rack. For some reason they did not give the racks a test that would cover all classes of service. We think such a rack is necessary to prevent damage to case goods such as canned goods, sacked goods and basket goods. Some shippers are now demanding removal of crosswise racks when loading cars, which is a reminder that before 1918 the shipper supplied the false floor when he wanted it and the railroads made allowances when they failed to return the racks, and it was not long after federal control when all the carriers were equipping cars with permanent false floors. You, perhaps, have been called to pass on refrigerator cars, which it is claimed damage freight because of small openings around doors and plugs. Those in position to know, say this is the bunk. During May, 1936, the Freight Container Bureau, Association of American Railroads, ran a test car of celery from Florida to New York, to determine the effect of small cracks. There was little or no effect on temperature.

We still have too many different kinds of seal locks and hand brakes. Many of our appliances were developed by car and mechanical men. Perhaps they can help develop a uniform seal lock and hasp that will permit proper sealing and one that will not break under handling or show up without a pin as many do. Claim men first recommended standardizing of doors and fixtures back in 1922—we still want it.

We have been talking tank cars for years, all because of the difficulty of getting shipper loaders to follow the simple device of removing the outlet cap before starting the loading, which is the only sure way of knowing that the valve is properly seated and will not leak en route. We need the help of the car man here. One thought in connection with errors creating loss and damage is that we are beginning to hear about difficulty in reading or deciphering car numbers on freight cars. We have had experience with illegible car numbers on waybills. We hope we do not have the car itself added to that headache. Added to this, we have failures in removing old side cards. Every time a car is loaded, the old card should be taken off.

Last year the car service division complained about the use of high-grade cars for commodities which render them unfit for handling high-class traffic, which tends to keep open the age-old question of uniformity in commodity carding of freight cars. The claim man is interested in this question. We have had cases of very dangerous commodities contaminating a car. Car men might well advocate some penalty rule or some scheme whereby such cars will be carded home for proper cleaning or repairs. While it would involve changes in a great many rules, the remedy will probably not be approached until the rules prevent re-use of cars until cleaned and repaired, which action may force the next step—that of supervision against the inexcusable destruction of the useful value of 100 per cent equipment which is also destruction of railroad property.

One great difficulty is that of inducing users of freight cars to pull nails. Allowing for the natural disinclination of some folks to go out of their way to do something they do not have to do, perhaps we could induce some unloaders to help by presenting them with a simple tool that will do the job. A railroad shop can manufacture a gooseneck claw bar, approximately 30 in. long and ¾ in. thick at a cost of $1.06. With this tool a hardwood post should present no obstacle to the easy pulling of nails.

Years ago, we tried to induce grain unloaders to mark with chalk at points where cars leaked. We were never able to get this done as regular practice. At least one road has now established the practice of chalk-marking all defects to guide future repair work. It is a good practice from our standpoint.

Condensation is a current problem receiving expert attention. A great many different kinds of cars are under test. One road has two cars equipped with louvers which permit air circulation but prevent cinders entering car; there are other ventilator schemes indicating that much thinking is along that line. Some shippers are using anchor plates applied to freight-car walls for engaging the ends of steel strapping used as bracing for certain commodities. They are fastened with eight lag drive screws each 1¾ in. long and ⅛ in. in dia., with the result that car siding is destroyed in removing them. We have this up but you can help by inducing shippers to use nails instead of these heavy drive screws.

The Freight Container Bureau of the A. A. R. has designed a metal pocket which can be built into the car to serve as a permanent anchor plate. They call it the Conbur Brace. Those who are interested can secure a copy of descriptive circular from the bureau. When I talked to you on September 2, 1930, I gave a tabulation of tons per car and damage applying to lightweight commodities which account for the bulk of transit damage. I was talking of friction springs. A lot of water has passed over the dam since then, almost eight years ago. I won't go over that ground again. Many additional cars have been equipped with friction springs.

Impact Speeds Must Be Limited

Hot boxes are ever with us and, regardless of alleged poor oil or poor oiling or other contributing causes for waste grabs and other reasons, we can say that excessive speed at time of impact contributes its share and that brings in the car man, because if cars receiving that kind of handling have to be re-worked by your inspectors before they take the road, to play safe, you have a good talking point. Just as some journal-box packers are extra good, so are some of our car handlers. The train man knows what happens when a journal runs hot, but he doesn't know what happens when cars are struck too hard—the car man can tell him. We are interested in the damage which results from over-speed impact—so are you.

I think it is understood that we can secure or obtain friction draft gears today with 2¾-in. travel, which will allow freight cars to be switched without closing the gear or causing damage up to speeds of five miles an hour, except the 90-ton and cars of greater capacity, but where is the yardman who is ready to determine on the spot that he has this kind of gear or that kind of car? When is he to know when he produces over 400,000 lb. of resistance and exceeds the safe load on the coupler shank? I am not a draft-gear man, neither are the yardmen, but you folks know enough about it to keep their thought in the safety zone by talking these things at meetings.

Two St. Louis roads stencil on the inside of their cars "Prevent Loss and Damage" or "Be Careful to Prevent Loss and Damage." We wish all roads would do this. In these days of stress, we need constant reminders. It only requires one or more earnest men interested in prevention in every yard to convert the unbeliever, help unload the alibi, and reduce the chances for rough handling. The lightweight freight car has been coming for a number of years. We certainly must meet it with lighter handling in train yards. We must go backward from heavier handling of heavier cars to lighter handling of lighter cars.

Questions and Answers On the AB Brake

Brake Cylinders (Continued)

323—*Q.—What observation should be made during the reduction?* A.—That an emergency application does not occur.

324—*Q.—What test should follow?* A.—The emergency test.

325—*Q.—How is this test conducted?* A.—With the device handle in lap position, open the ⅜-in. cock connected to the brake-pipe side of the test device.

326—*Q.—What is developed from this act?* A.—As the opening of the cock makes a reduction of the brake-pipe pressure suddenly, or at a fast rate, an emergency application must be obtained.

327—*Q.—How is it indicated?* A.—By the venting of the brake-pipe pressure to zero.

328—*Q.—In rare instances, what will cause failure to obtain the emergency?* A.—It may be caused by a decrease in the quick-action-chamber volume in the pipe bracket.

329—*Q.—How would this happen?* A.—It would be caused by an accumulation of moisture, which should be removed.

330—*Q.—What test should follow the emergency test?* A.—The release test after emergency.

331—*Q.—What should be done before attempting a release at the completion of the emergency test?* A.—Wait approximately 1 min.

332—*Q.—Why is this necessary?* A.—To permit the quick-action-chamber air to exhaust to the atmosphere.

333—*Q.—If this precaution is not taken, what would be the result?* A.—The quick-action-chamber air keeps the vent-valve piston to the right, holding the vent valve off of its seat, allowing brake-pipe air to escape to the atmosphere.

334—*Q.—How would you proceed to make the test?* A.—Move the test-device handle to No. 1 position until the brake pipe is charged to 20 lb., then move the handle to position No. 2.

335—*Q.—What must be observed after this?* A.—That the emergency piston moves to the accelerated-release position when the brake-pipe gage shows not less than 20 lb. or more than 28 lb.

336—*Q.—How is this piston movement indicated?* A.—By a rapid rise of brake-pipe pressure.

337—*Q.—What causes this rise?* A.—Air flowing into the brake pipe from the brake cylinder which is at this time connected to the auxiliary reservoir by way of the service valve.

338—*Q.—When is this flow of air into the brake pipe cut off?* A.—When the pressures are nearly equalized.

339—*Q.—What then controls the rate of the brake-pipe pressure build up?* A.—The test device.

340—*Q.—How long should this test be continued?* A.—Until the brake-cylinder piston returns to release position.

341—*Q.—What test should be made for brake-cylinder leakage only?* A.—Test should be made by using a test fitting inserted in the retaining valve pipe.

342—*Q.—How should this test be started?* A.—With 70 lb. pressure in the brake pipe, make a 20 lb. reduction by means of a single-car test device, returning the device handle to release position.

343—*Q.—Why is the test-device handle returned to release position?* A.—In order to have the service piston returned to release position.

344—*Q.—Does this movement discharge the brake-cylinder air to the atmosphere?* A.—Not in this case, as the test device in the retaining valve pipe retains the pressure.

345—*Q.—How much pressure would be retained?* A.—50 lb.

346—*Q.—What piston travel should be maintained for this test?* A.—7 in.

347—*Q.—Would it be satisfactory to obtain the brake-cylinder pressure by means of an emergency application?* A.—No. A service application should be made.

348—*Q.—In the event that a cylinder pressure higher than 50 lb. is obtained, should test be made anyhow?* A.—No. The pressure should be reduced to 50 lb. at the gage fitting.

349—*Q.—What is the maximum brake-cylinder leakage permitted?* A.—5 lb. per min.

350—*Q.—How would the test be made to cover combined brake-cylinder retaining valve and piping leakage?* A.—The cock in the test fitting is so turned as to connect the brake-cylinder pressure to the retaining valve via the retaining valve pipe. The retaining valve handle is placed in the high-pressure position.

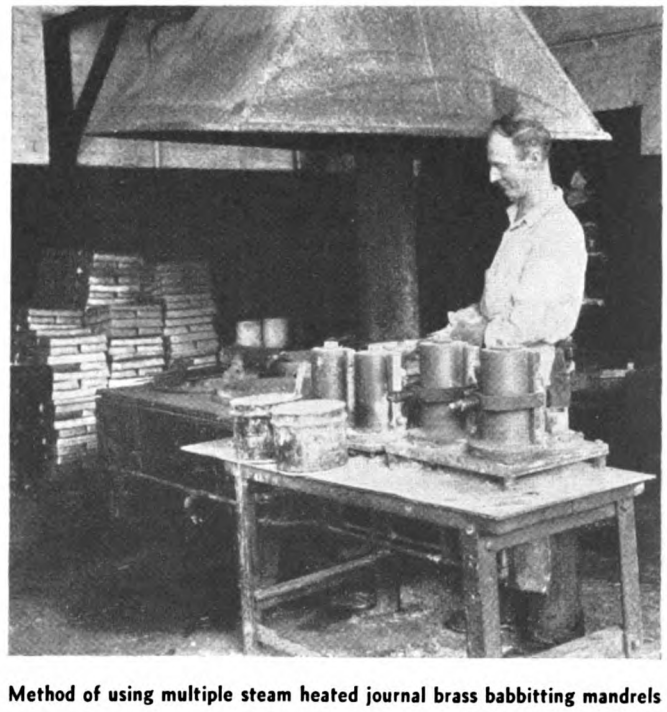
351—*Q.—At what pressure is the rate of leakage determined?* A.—15 lb.

352—*Q.—What should be the maximum allowable leakage per minute from 15 lb.?* A.—3 lb.

353—*Q.—If it were desired to obtain the blow-down rate of the retaining valve, how is this ascertained?* A.—With the retaining valve handle in high-pressure position, note the time required to reduce the combined pressure from 40 to 25 lb.

Steam-Heated Babbitting Mandrels

To eliminate cold shuts in babbitting car-journal brasses, steam-heated mandrels are used at the Northern Pacific shops, Brainerd, Minn., being constructed as shown in the illustration. The mandrels are kept at an even temperature, cold shuts being eliminated and the time required for preheating of mandrels greatly reduced. Due

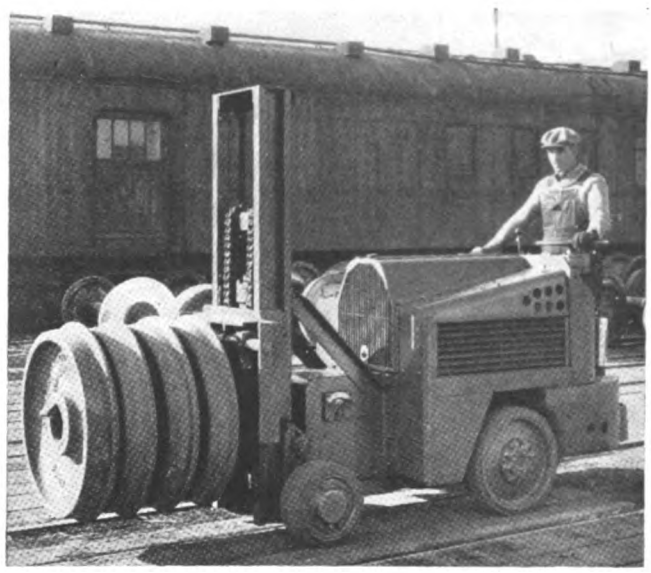


Method of using multiple steam heated journal brass babbitting mandrels

to longer time required for cooling of babbitt when using these mandrels, four mandrels are mounted on the bench to provide continuous work for the operator. Mandrels are mounted on a plate above the bench top to provide for circulation of air between the mandrels and bench top. Steam is piped under and up through the bench top to the mandrels.

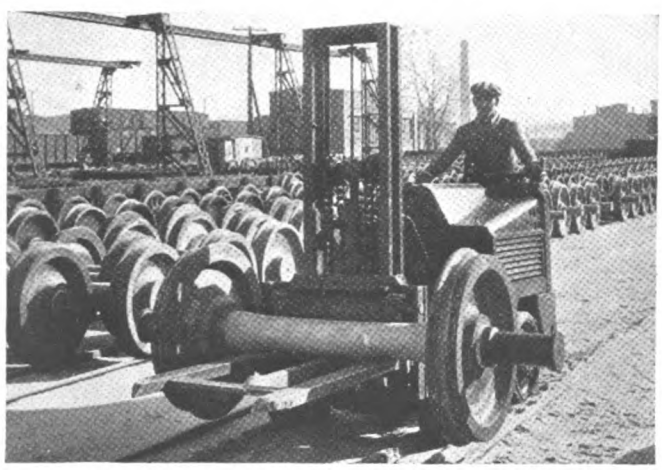
Heavy-Duty Fork Truck Is Motor Operated

The Elwell-Parker Electric Company, Cleveland, Ohio, is marketing a motor-operated fork truck with a rated capacity of 6,000 lb. and travel speeds up to 10 m. p. h. It is designed for the use of a ram, a fork or other accessory attachments that enable it to pick up any kind of load by direct contact, or on a pallet or a skid. Loads



The Elwell-Parker truck fitted with a ram for handling car wheels

can be lifted from the floor, transported in a tilted position, and stacked without the operator leaving his position. The elevating equipment is operated by a cylinder which receives oil from a vane-type hydraulic pump, direct driven from the truck motor; however, lowering is accomplished by using a manually operated valve. The movement of the forks, either up or down, can be stopped instantaneously at any point of travel. Separate hydraulic rams tilt the upright standard to forward and back positions by means of levers.



Elwell-Parker gas-operated fork truck

The truck is powered with a four-cylinder gasoline engine which develops 33 hp. at a normal engine speed of 1,250 r. p. m. It has two-wheel drive, and is steered from the four wheels, steering being by hand through gear reduction. The truck has sufficient power to handle loads up steep ramps at high speeds; however, for safety, a transmission lock is used to hold the truck should it be necessary to stop it on a ramp. This same transmission lock permits acceleration when starting the truck after stopping on an incline.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Repairs Claimed Excessive And Unwarranted

The Southern made repairs at its Columbia, S. C., shops to four Seaboard Air Line cars in September, 1936, and returned the cars empty to the owner within from one to five days after the repairs had been completed. The Southern later billed the S. A. L. to the amount of $546.09 for these repairs, but the S. A. L. contended that the charges should be canceled since (1) it connects with the Southern at Columbia, (2) it also has a shop at that point capable of making the repairs, and (3) failure of the Southern to send the cars to the home shops constituted a direct violation of A. A. R. Rule 1.

The Southern contended that a short time prior to its making the repairs the owner used the cars in revenue service on its own lines with the defects existing, and that the defects, which consisted of nailing sills and flooring badly decayed and part missing, constituted a hazard to train men and rendered the cars unfit for revenue service. At the time the repairs were made, the Southern pointed out that the cars were in great demand and it had no definite knowledge that the cars would not be loaded on its lines; also, since temporary repairs could not be made at a reasonable cost, complete repairs were made in accordance with the owner's standards.

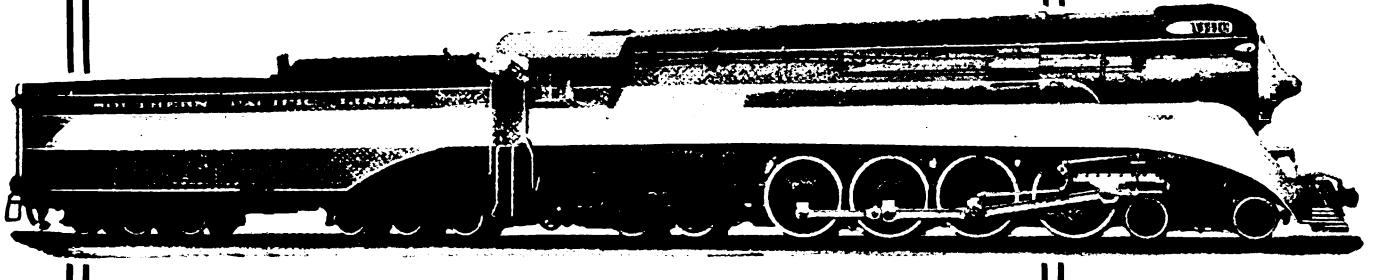
A decision rendered by the Arbitration Committee on November 11, 1937, stated that: "The contention of the Southern that the cars were unsafe and unserviceable is untenable in that one car was received from the owner empty and subsequently loaded, two other cars loaded by the Southern while on its line and fourth car received under load and moved empty after unloading, indicated that the cars were safe and serviceable when received on line and until cars were received at the point where repairs were made.

Since the point where repairs were made is also a point of direct connection to the car owner, it is considered the repairs were made in violation of Rule 1 (b). The contention of the owner is sustained."—*Case No. 1760, Seaboard Air Line versus Southern.*

(Turn to next left-hand page)

STEAM

WILL PROVIDE ANY TRAIN SPEED YOU CAN USE



Modern Super-Power Steam Locomotives remove the limitation of speed due to motive power. They make it possible to operate with safety at any train speed permitted by other considerations.

Without introducing any unproven elements the Super-Power Steam locomotive meets all the requirements of high-speed passenger service.

LIMA LOCOMOTIVE WORKS, INCORPORATED
LIMA, OHIO

LIMA
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INCORPORATED

High Spots in
Railway Affairs . . .

Few More Railroaders Working

According to the preliminary report of the Interstate Commerce Commission there were 929,477 employees on the railroads in July. This was an increase of 14,712, or 1.61 per cent over the previous month. Taking the 1923-25 average as 100, and allowing for seasonal variations, employment in July of this year stood at 50.7 per cent. Maintenance of equipment and stores forces were 29.28 per cent under July, 1937, although the reduction of the total forces for the same period was only 20.86 per cent.

All About Motor Vehicle Drivers

The Interstate Commerce Commission is having its own troubles in solving the problem of how best to regulate common and contract motor vehicle carriers engaged in interstate commerce. Apparently it proposes to learn everything it possibly can about these services. For one thing, a study has been made by its Bureau of Motor Carriers of the drivers of the buses and motor trucks. As of July 1, 1937, data were submitted by 22,532 carriers for 128,038 drivers. Based on an analysis of about one-third of these returns, it was found that the average driver was 33.3 years old, 5 ft. 8¼ in. high, and weighed 165.4 lb.—a rather hefty bunch. The youngest drivers were 15 years old and the oldest 79 years. Of the 40,107 drivers considered in this study, 76 were below 18 and 300 were more than 60 years of age. Only 28 were women. On the average, the drivers had worked for their present employers 4.3 years; their average experience in driving trucks or buses, however, was 13.8 years, representing 250,000 miles of driving. While physical examinations were required of many of the drivers, no such examinations were reported to have been taken by 30.6 per cent of the bus drivers, 73 per cent of the truck drivers, and 40.9 per cent of the bus-truck drivers.

Moving a Bumper Wheat Crop

Thus far this year the railroads have successfully handled the wheat crop. While it is much larger than that of last year, or any year since 1915, its movement is being spread over a longer period than usual. The railroads this year made still further improvements in planning to insure an adequate supply of grain carrying cars for the crop movement. Wet weather in wide areas also forced a return from the combine to the thresher-and-binder method of harvesting, thus considerably slowing up this work in these sections. In addition, the program for government loans on wheat and the low prices which have prevailed, have caused the farmer to hold back much grain from shipment. Because of this slowing up and spread of the movement, the railroads have been relieved of considerable extra expense in the transferring of men and locomotives, and other emergency measures. It is said, also, that there will be a heavy reduction in the claims for seepage and loss of grain because of the better cooperage of the cars and the fact that there is available an ample supply of properly constructed grain doors. It is estimated that the wheat crop in the United States will be 967,412,000 bushels, compared with 873,993,000 bushels last year, and an annual average of 752,891,000 bushels in the last 10 years.

The Wage Controversy

The controversy over the proposal of the railways to reduce wages 15 per cent is now in its second stage. The negotiations between the carriers and their employees, which started on July 18, ended in a deadlock on August 3, and in accordance with the Railroad Labor Act, the services of the National Mediation Board were invoked. Because of its importance and the graveness of the situation, all three members of the board, Chairman William H. Leiserson, Otto S. Beyer and George A. Cook, are sitting in the hearings. These are being held behind closed doors and the board has indicated that silence on its part will be maintained until a agreement is reached, or until the efforts to mediate fail. The Brotherhood of Railroad Trainmen is still maintaining its aloofness from the rest of the labor group, and thus the Mediation Board is compelled to deal with three parties, holding separate meetings with the Carriers Joint Conference Committee, the Railroad Labor Executives Association, which represents 18 organizations of railway employees, and the Brotherhood of Railroad Trainmen. The meetings started in Chicago on August 11 and when this item was prepared there was no indication that an early agreement or disagreement would be reached.

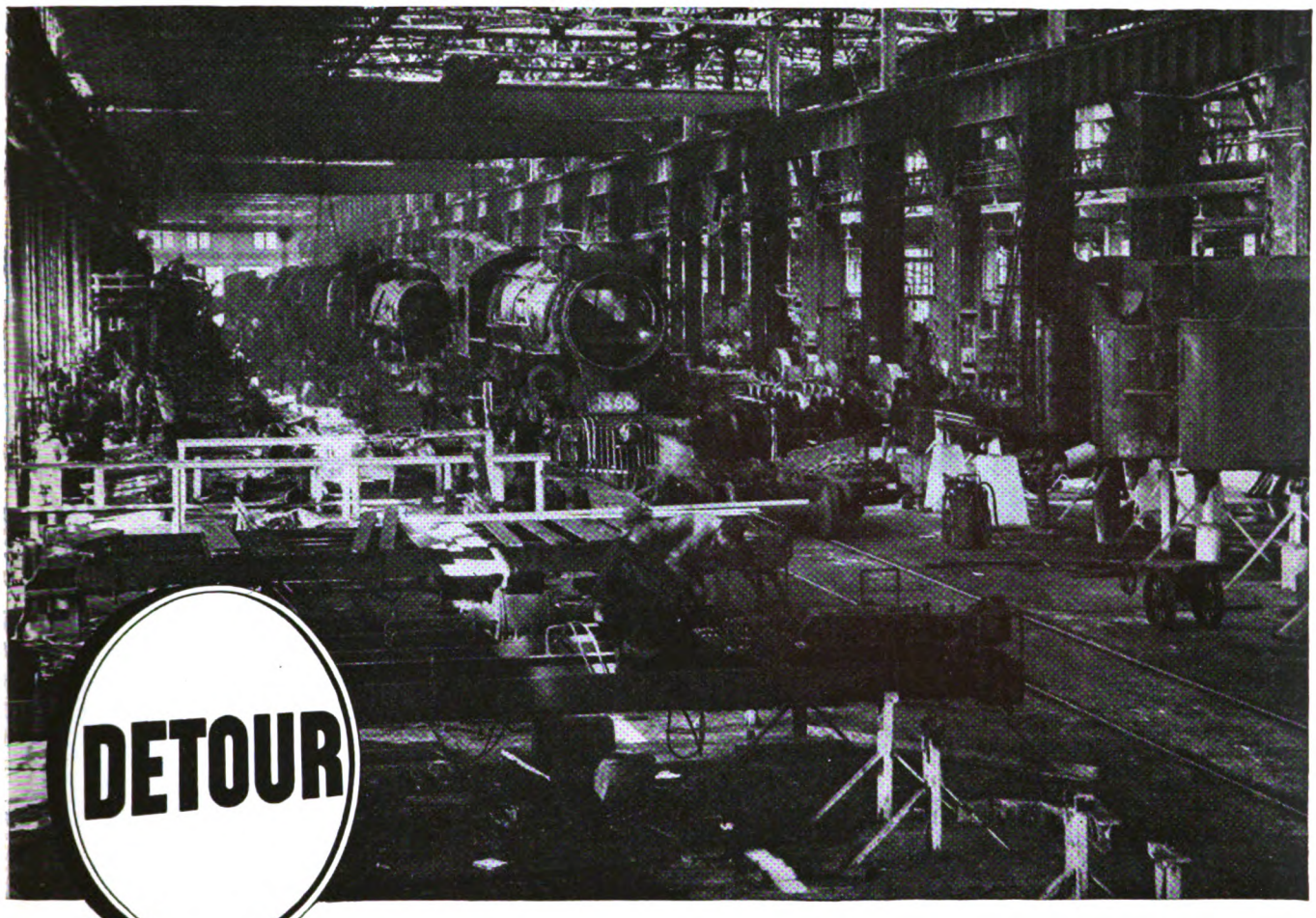
Rutland Workers Stay On the Job

Federal Judge H. B. Howe viewed the financial contingency on the Rutland so seriously that he indicated that the employees of that road could not remain as employees after August 4 unless they consented to a reduction of wages of from 10 to 30 per cent, according to the weekly bases. An agreement was finally made to withhold such amounts, but the deductions will not constitute a prior lien on the property against liens and obligations having priority in time, and will be made up only in the event of increased earnings by the carrier. The employees accepted these terms under protest. This action does not reduce expenses, but it does conserve the cash. The Rutland employees have now joined with the employees of the other railroads in fighting the proposed 15 per cent reduction in wages. The officers and members of the staff have already had their salaries drastically reduced. The shippers and business men along the road have formed the Rutland Railroad Cooperating Traffic Association, the purpose of which will be to assist the road in building up traffic and getting back on a sound financial basis. The city of Rutland has appropriated $1000 to the association and has voted to abate water assessments levied on the road for a period of one year, amounting to more than $2500.

Rail-Auto Plan On the New Haven

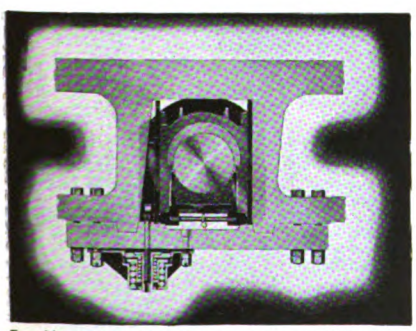
Salesmen frequently drive their automobiles for long distances from their headquarters to the field, in order to have them available for making local calls or of using them more or less intensively in a comparatively limited territory. In such cases the railroads lose the long haul business, although the development of "Drive-Ur-Self" automobiles in many places has reacted to their benefit. Now comes the New Haven with the announcement that reduced mileage rates on Hertz "Drive-Ur-Self" automobiles may be obtained by its patrons in nine of the key cities which it serves. A standard receipt for railroad fare when a ticket is purchased will be evidence of transportation over the railroad. The cost of a reservation telegram up to 35 cents will be credited to the automobile rental charge. Passengers will also be transported free of charge between the railroad station and the Hertz garage.

(*Turn to next left-hand page*)



. . . around the Repair Shop

Pounding driving boxes, brought about by improper wedge adjustment, soon has the locomotive traveling over an expensive section of the road—the one leading to the repair shop . . . Detour around this stretch by eliminating the cause with the application of the Franklin Automatic Compensator and Snubber. » » » With this application, any expansion and contraction that occurs in the driving box is taken up automatically . . . while the locomotive is running. In addition, a heavy spring acts as a cushion to take care of any abnormal shocks. » » » For easier riding, prevention of pounds, reduced tire wear, and less frequent trips to the back shop, incorporate the Franklin Automatic Compensator and Snubber.



Franklin Automatic Compensator and Snubber

The close tolerances essential to efficient operation call for genuine repair parts. Franklin makes them exact.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL



All the locomotive fans are not in America—Correctly proportioned working models of modern and historic locomotives in the Railways Museum, Stockholm, Sweden

NEWS

Four Historic Locomotives Now in Museum at Chicago

THE Chicago & North Western's "Pioneer" of 1848, the Illinois Central's "1401" of 1880, the Natchez & Hamburg's "Mississippi" of 1834, and the Baltimore & Ohio's "York" of 1831 have been installed in the Museum of Science and Industry at Chicago as a permanent exhibit. Replicas of these original locomotives have been made and will be used by the railroads for exhibition purposes.

P. R. R. Shop Crafts Election

PLANS are under way for an election under National Mediation Board supervision to determine the union which will represent the 30,000 to 35,000 shop craft employees of the Pennsylvania, it has been revealed by Secretary Robert F. Cole of the Board. Contesting organizations in the election, the largest ever conducted by the Board, would be the American Federation of Labor's Railway Employees Department and the Brotherhood of Railroad Shop Crafts of America, Pennsylvania System. Two mediators of the National Mediation Board are now surveying the situation.

Equipment Leases

The Chicago Great Western has entered into a contract with the Pullman-Standard Car Manufacturing Company for the leasing of 50 light-weight, all-welded, steel box cars of 50 tons' capacity, with an option to buy.

The Chicago, Rock Island & Pacific has entered into a contract with the Electro-Motive Corporation for the leasing of 16 Diesel-electric locomotives, with an option to buy, thereby bringing the total contracted for to 37, including 10 leased in April and 11 in March. Of the 37, 29 are 600 hp. and 8 are 900 hp.

Equipment Depreciation Orders

EQUIPMENT depreciation rates for six railroads, including the Denver & Rio Grande Western, have been prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15,100, Depreciation Charges of Steam Railroad Companies. The composite percentages, which are not prescribed rates, range from 3.61 for the D. & R. G. W. to 4.14 for the Sumter & Choctaw.

The D. & R. G. W.'s prescribed rates on standard-gage equipment are as follows: Steam locomotives (new), 3.13 per

(*Continued on next left-hand page*)

New Equipment Orders and Inquiries Announced Since the Closing of the July Issue

LOCOMOTIVE ORDERS

Company	No. of Locos.	Type of Loco.	Builder
Boston & Maine	3*	600-hp. Diesel-elec.	Electro-Motive

LOCOMOTIVE INQUIRIES

Ferrocarill de Antioquia	2	2-8-2	.....
Wheeling & Lake Erie	5	2-8-4	.....

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Southern	23	40-ton box	Pullman-Standard
	20	40-ton box	Mt. Vernon
	95	50-ton gondola	American Car and Fdry.
	3	40-ton stock	Ralston Steel
	11	50-ton gondola	Pressed Steel
	1	70-ton flat	Greenville Steel
Total	153†		
Manila	50	30-ton box	Pressed Steel
	50	30-ton flat	Gregg Company

FREIGHT-CAR INQUIRIES

Illinois Central	‡	.....	.....

PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Newfoundland Railway	1	Dining	National Steel Car
	2	Sleeping	National Steel Car

PASSENGER-CAR INQUIRIES

Southern	6	2-car trains§	.....

* Delivery taken.
† In addition to the 5,550 cars reported in the June issue.
‡ Inquiry for prices of parts for 1,000 box cars.
§ Diesel-electric powered.

SUPPOSE EVERY RAILROAD HAD ITS OWN ARCH BRICK DESIGN



Look about and see how standards on many items vary with each railroad. » » » Think of the confusion and expense involved if this also applied to Arch Brick. » » » If a road ran short, it would wait for weeks for its special brick to be made! At joint terminals, the confusion would be unendurable. » » » Years ago, American Arch Company foresaw such a situation and fostered the standardization of Arch tubes and of Arch Brick sizes and designs. » » » Think of the grief this good work saved. » » » In everything having to do with Arch Brick, American Arch Company for a quarter of a century has served the railroads. This service has had and still has a high value.

THERE'S MORE TO SECURITY ARCHES THAN JUST BRICK

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

cent; steam locomotives ("second cycle equipment"), 4.1 per cent; freight-train cars (new), 3.17 per cent; freight-train cars (second cycle), 3.86 per cent; passenger-train cars (new), 4.03 per cent; passenger-train cars (second cycle), 3.75 per cent; work equipment (new), 3.14 per cent; work equipment (second cycle), 3.67 per cent; miscellaneous equipment (new), 14.52 per cent; miscellaneous equipment (second cycle), 18.69 per cent. On narrow gage equipment the respective percentages for new and second cycle equipment are as follows: Steam locomotives, 3.1 per cent and 3.55 per cent; freight-train cars, 3.11 per cent and 3 per cent; passenger-train cars (second cycle), 3.27 per cent; work equipment, 3.16 and 3 per cent.

Supply Trade Notes

LUDWIG EMDE has been appointed Detroit district sales manager of the Worthington Pump and Machinery Corporation, Harrison, N. J.

◆

FRANK D. NEWBURY, has been appointed manager of the New Products division of the Westinghouse Electric & Manufacturing Co., to succeed Herbert M. Wilcox, deceased.

◆

NORMAN L. CAVEDO has been appointed southern representative of Crerar, Adams & Company of Chicago, with headquarters at 1717 Summit avenue, Richmond, Va. The Richmond office supersedes the sales division of the company's Washington, D. C., unit. Mr. Cavedo, who will sell railway supplies to all the southern railroads, also continues to represent the Federal Foundry Supply Company of Cleveland, Ohio.

◆

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO. has consolidated its transportation and generator divisions, and Frank Howell Stohr, manager of the generator division since last December, has been appointed manager of the combined transportation and generator division, with headquarters at East Pittsburgh, Pa. Frank B. Powers, formerly manager of transportation engineering, becomes engineering manager of the combined divisions.

◆

V. B. EMRICK, representative of the Westinghouse Air Brake Company at St. Louis, Mo., since 1930, has been transferred in the same capacity to the southeastern district at Washington, D. C. Mr. Emrick, after serving with the Atchison, Topeka & Santa Fe, was employed by the Locomotive Stoker Company. He entered the employ of the Westinghouse Air Brake Company in 1929 as mechanical expert at the St. Paul, Minn., office and a year later was appointed representative at St. Louis.

Obituary

HERBERT M. WILCOX, manager of the New Products division, of the Westinghouse Electric & Manufacturing Co., died suddenly from heart disease on July 28, in New York City. As manager of the newly created New Products division, Mr. Wilcox played an active part in introducing the Westinghouse precipitron, an electrostatic air cleaner.

◆

COL. WILLIAM A. SMETHURST, of the sales department of the Baldwin Locomotive Works, at New York, died on August 12, at the Harkness Pavillion, Columbia-Presbyterian Medical Center, New York City, after five months' illness. Col. Smethurst was born 65 years ago in St. Augustine, Fla., and studied at Penn Charter School, Philadelphia, Pa. He entered the World war with the rank of major in the corps of engineers and was later promoted to lieutenant colonel. Since the war he had been in the service of the Baldwin Locomotive Works.

◆

JOHN A. MACLEAN, president of the MacLean-Fogg Lock Nut Company, Chicago, died in that city on August 13. Mr. MacLean was born May 4, 1874, at Buffalo, N. Y., and entered the employ of the Corn Exchange Bank, Chicago, in 1892, with which organization he remained until 1902. From the latter year until 1905 he was in the employ of the Federal Trust and Savings Bank, Chicago, and from 1906 to 1909 was engaged in the insurance business. In 1910 he entered the employ of the American Locomotive Equipment Company, but a year later resigned to become associated with the Boss Nut Company, with which company he remained until 1925. In 1926 he was elected president of the MacLean-Fogg Lock Nut Company.

◆

CHARLES HENRY TOMLINSON, formerly for 28 years sales engineer of the coupler division of the Ohio Brass Company, Mansfield, Ohio, died at his home in Mansfield, on August 10, following an illness of several months. Mr. Tomlinson was born at St. Louis, Mo., on July 6, 1869, and spent the early years of his business career in the West until 1906, when he left the Denver Tramways to go with the Ohio



C. H. Tomlinson

Brass Company as sales engineer of its coupler division, from which position he resigned in 1933 because of ill health. Mr. Tomlinson's work was identified with the development of automatic couplers for electric railways and more recently, tight-lock couplers for steam-railroad cars.

Personal Mention

General

R. P. DOLLARD has been appointed shop engineer of the Chesapeake & Ohio.

A. STURROCK, master mechanic of the Esquimalt & Nanaimo, at Victoria, B. C., has been appointed assistant superintendent with the same headquarters.

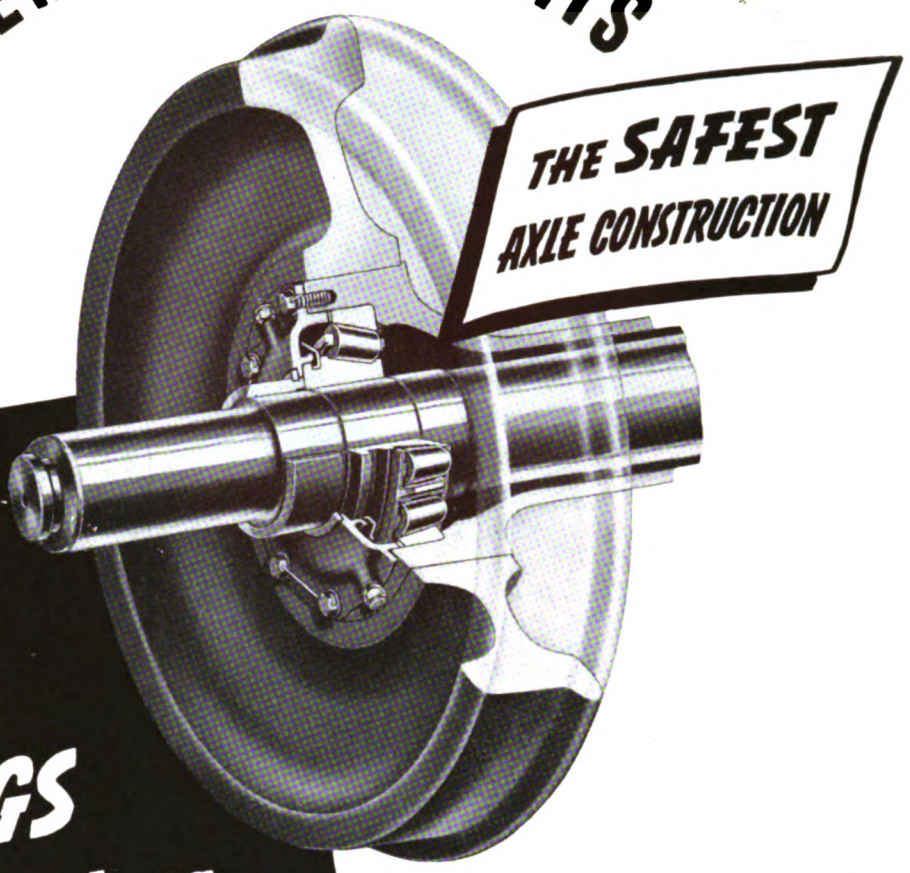
GEORGE H. LICKERT, fuel engineer for the Union Pacific, has retired, after 37 years' service in capacities ranging from machinist to master mechanic.

E. C. MITCHELL has been appointed motive power inspector of the Huntington division of the Chesapeake & Ohio, with headquarters at Huntington, W. Va., succeeding S. E. Fulks, whose appointment as road foreman of engines, Handley coal sub-division was announced in the August issue of the *Railway Mechanical Engineer*.

NICHOLAS MCLEAN TRAPNELL, who has been appointed assistant to superintendent motive power of the Chesapeake & Ohio at Richmond, Va., as announced in the July issue of the *Railway Mechanical Engineer*, was born on December 30, 1900, at Elizabeth, N. J. He was graduated from Stevens Preparatory School, Hoboken, N. J., and studied mechanical engineering at Stevens Institute of Technology. Mr. Trapnell entered railroad service in July, 1919, as a machinist helper with the Coal & Coke Railway at Gassaway, W. Va. In February, 1921, he became junior marine engineer for the U. S. Shipping Board and later for the Barber Steamship Company. In April, 1922, he was appointed machinist, Meadows shops, New York division, Pennsylvania Railroad. In September, 1924, he became draftsman and later mechanical engineer for the Weston Electrical Instrument Company at Newark, N. J. In December, 1928, Mr. Trapnell

(*Continued on next left-hand page*)

A·S·F ROLLER BEARING UNITS



THE SAFEST AXLE CONSTRUCTION

WHEELS
AXLES
BEARINGS
...handled as one assembly

The handling of A. S. F. Roller Bearing Units follows standard railway practice.

Applied and removed like plain bearing wheel and axle assemblies.

Wheels turned without disturbing or protecting roller bearings.

Can be applied to existing equipment.

Wheels changed without removing roller bearings. Ordinary wheel presses used.

Being an integral assembly, the A. S. F. Roller Bearing Unit is easy and inexpensive to maintain.

AMERICAN STEEL FOUNDRIES

was appointed assistant engineer, operating department, Chesapeake & Ohio, at Richmond, becoming special engineer on the



N. M. Trapnell

staff of the vice-president and general manager in April, 1933. He was appointed mechanical engineer in August, 1936.

STEPHEN E. MUELLER, whose promotion to superintendent of motive power, second mechanical district, of the Chicago, Rock Island & Pacific, with headquarters at Kansas City, Mo., was announced in the August issue of the *Railway Mechanical Engineer*, was born at St. Louis, Mo., on



Stephen E. Mueller

January 31, 1885, and began railway service with the Rock Island on December 21, 1907, as enginehouse foreman at Rock Island, Ill. On June 1, 1910, he was promoted to general foreman at Fairbury, Neb., and later served as a general foreman at Rock Island and Cedar Rapids, Iowa. On October 1, 1919, Mr. Mueller became master mechanic at Estherville, Iowa, and on February 15, 1920, he was appointed assistant superintendent of shops at Silvis, Ill. Mr. Mueller became superintendent of shops at Silvis, Ill., on July 1, 1922.

ALVIN R. RUITER, whose promotion to assistant chief operating officer, mechanical, of the Chicago, Rock Island & Pacific was announced in the August issue of the *Railway Mechanical Engineer*, was born at Dumont, Iowa, on January 26, 1880. He entered railway service on the Rock Island as a machinist at Valley Junction, Iowa, on November 19, 1906 and later served as machinist foreman and enginehouse foreman. On January 1, 1913, he became general foreman at Valley Junction, and on June 1, 1915, was transferred to Silvis, Ill. He was later appointed master mechanic at Armourdale, Kan. Mr. Ruiter served also as master mechanic at Armour-



Alvin R. Ruiter

dale, Chickasha, Okla., and Shawnee, Okla., and was master mechanic at Armourdale at the time of his appointment as assistant chief operating officer mechanical.

Master Mechanics and Road Foremen

MURRAY KENNETH ROBB, who has been appointed master mechanic of the Canadian National at Prince Albert, Sask., as noted in the August issue, was born on July 16, 1891, at Smith's Falls, Ont. He attended Public School Collegiate at Ottawa, Ont., entering the service of the Grand Trunk Pacific (now the Canadian National) as a messenger in the freight department. He subsequently became a machinist apprentice; machinist at Fort William, Ont.; machinist at Transcona, Man. (in 1915), and machinist at Sioux Lookout, Ont. (in 1917). In March, 1918, he was transferred to Regina, Sask., as shop foreman. He was appointed locomotive foreman at Regina in October, 1918; at Nutana, Sask., in 1929; at Regina in 1931, and at Nutana in 1932. He became master mechanic at Prince Albert on June 15, 1938.

C. D. SMITH, who has been appointed master mechanic of the Portage Brandon Division of the Canadian National at Winnipeg, Man., as noted in the August issue, was born on February 23, 1888, at Creemore, Ont. He received a high-school education, and in June, 1903, became a machinist apprentice on the Canada Atlantic. He became a locomotive fireman on the Canadian Pacific in 1906. Mr. Smith entered the employ of the Grand Trunk Pacific (now the Canadian National) in 1907, and until June 16, 1938, served successively on the Canadian National as locomotive fireman, locomotive engineer, road foreman of engines, acting general road foreman of engines, and master mechanic at Sioux Lookout, Ont.

Shop and Enginehouse

E. A. BENDER, assistant enginehouse foreman of the Norfolk & Western at Bluefield, W. Va., has been promoted to the position of day enginehouse foreman.

B. W. HENLEY, day enginehouse foreman of the Norfolk & Western at Bluefield, W. Va., has been promoted to the position of general foreman, succeeding F. R. Forrest, deceased.

F. A. SARVER, gang leader at the Bluefield, W. Va., shop of the Norfolk & Western, has been transferred to the position of boilermaker foreman at Williamson, W. Va., succeeding W. D. Cassidy.

W. D. CASSIDY, boilermaker foreman of the Norfolk & Western at Williamson, W. Va., has been transferred to the position of night boilermaker foreman at Bluefield, W. Va., succeeding O. E. Chapman, deceased.

Purchasing and Stores

H. C. YOUNG, assistant purchasing agent of the Delaware & Hudson, with headquarters at Albany, N. Y., has been appointed acting purchasing agent, with the same headquarters, replacing H. K. T. Sherwood, resigned.

Obituary

FRANK R. FORREST, general foreman of the Norfolk & Western at Bluefield, W. Va., died on July 24.

J. BERTRAM YOUNG, engineer of tests of the Reading Company, died on July 29. Mr. Young was born on May 27, 1876. He became assistant chemist on the Reading on July 25, 1898; chemist, on July 1, 1906, and engineer of tests, on July 1, 1920.

M. A. KINNEY, former superintendent of motive power of the Hocking Valley and later general master mechanic of the Chesapeake & Ohio, with headquarters at Columbus, Ohio, whose death on July 16 was announced in the August issue of the *Railway Mechanical Engineer*, was born in Ashtabula county, Ohio, and first entered railway service on October 1, 1889 as a machinist apprentice on the Chicago, New York & St. Louis at Conneaut, Ohio. Mr. Kinney subsequently served the Nickel Plate as air-brake inspector, gang foreman at the Chicago shops, machine shop foreman and enginehouse foreman at Ft. Wayne, Ind. In February, 1904, he went with the Baltimore & Ohio as general enginehouse foreman at Newark, Ohio. In April, 1907, he become general foreman of the Mound Street shops of the Hocking Valley at Columbus. Later in 1907 he was appointed master mechanic, and on September 10, 1910, became superintendent of motive power. Mr. Kinney was appointed general master mechanic of the Chesapeake & Ohio with jurisdiction over the Hocking and Chicago divisions on May 1, 1930, following the acquisition of the Hocking Valley by the C. & O.

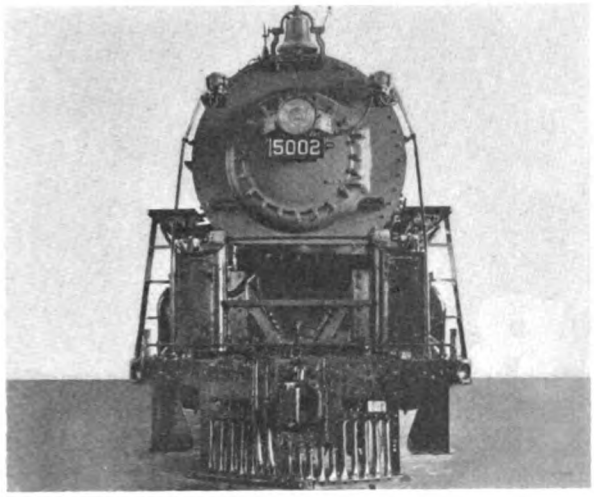
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Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.

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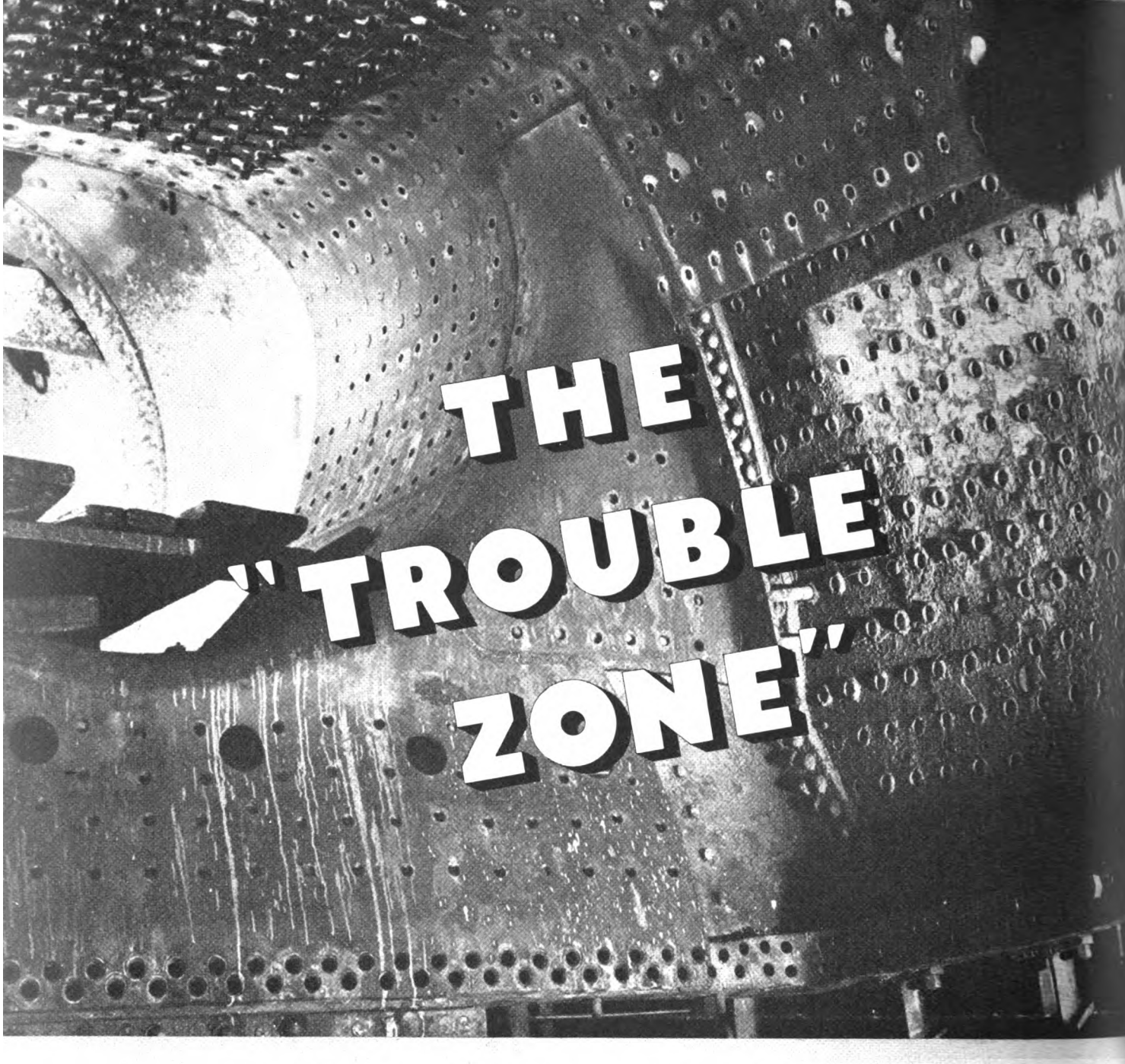
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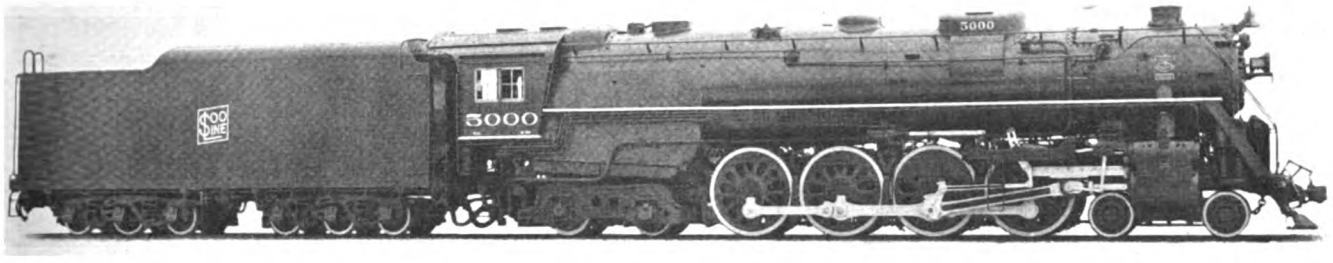
This area in the fireboxes of big locomotives has become known as the "trouble-zone." » » » Here circulation is poor and water stagnates, sheets heat easily, cracking at the staybolts and soon new sheets are needed. » » » To meet this severe service railroads are turning to longer-lasting Toncan* Iron, an alloy of open hearth iron, copper and molybdenum. Toncan Iron has uniform physical properties that absorb the complex stresses set up by rigidly anchored sheets working under high pressures and subject to unequal expansion and vibration. » » » It has greater resistance to chloride, sulphate and oxygenated water corrosion than any other ferrous material in its price class. » » » In actual locomotive service Toncan Iron has proved its ability to lengthen the life of locomotive fireboxes and reduce maintenance costs. You can specify it with confidence. » » » We will gladly send you further details. Address Department RM, Republic Steel Corporation. General Offices: Cleveland, Ohio; Alloy Steel Division: Massillon, Ohio.

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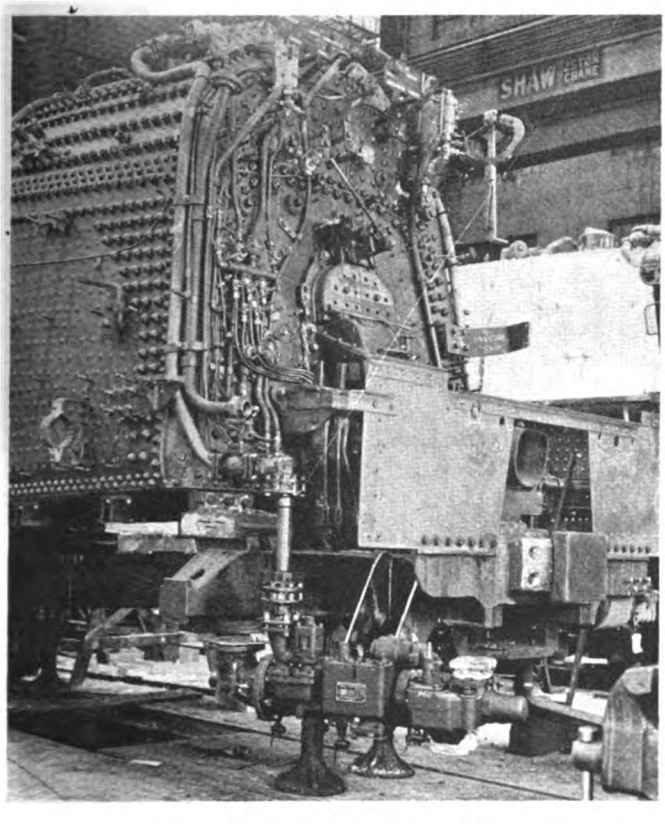
BERGER MANUFACTURING DIVISION • STEEL AND TUBES, INC. • UNION DRAWN STEEL DIVISION
NILES STEEL PRODUCTS DIVISION • TRUSCON STEEL COMPANY



Freight and passenger locomotive for service on the Wisconsin Central

Soo Line

4-8-4 Type Locomotives



The back head during construction

Four Lima-built engines develop 66,000 lb. tractive force with 75-in. drivers—The boilers carry 270 lb. pressure—Grate area, 88.3 sq. ft.; combined heating surface, 7,262 sq. ft.; total engine weight, 445,500 lb.

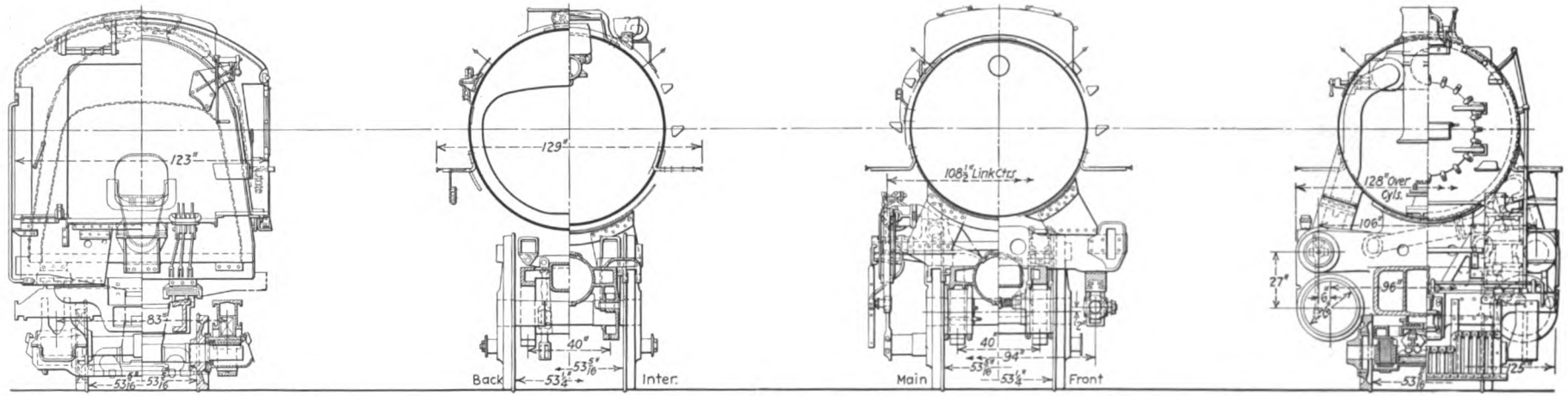
THE Minneapolis, St. Paul & Sault Ste. Marie received four locomotives of the 4-8-4 type from the Lima Locomotive Works during the early part of the present year. These locomotives are designed for freight and passenger service and are for use on the Wisconsin Central Line. With 75-in. driving wheels they develop 66,000 lb. tractive force. They carry a boiler pressure of 270 lb. and the cylinders are 26 in. in diameter by 32 in. stroke. The design presents well-balanced proportions and is generally conservative as to details.

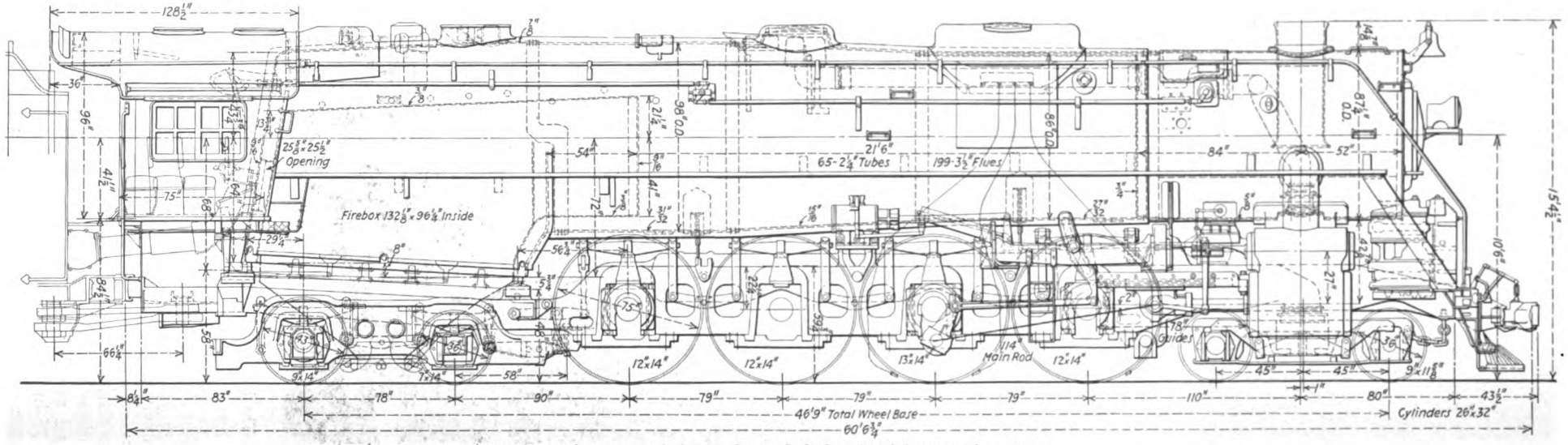
The Boiler

The boiler is conical in form, with an outside diameter at the first ring of 86 in., increasing to 98 in. at the third ring. The three barrel courses, the second of which is conical, are of silico-manganese steel. This material is also used for the welt strips and for the roof sheet over the firebox. The material in the first course is $^{27}/_{32}$ in. in thickness, increasing to $^{15}/_{16}$ in. in the conical course and $^{31}/_{32}$ in. in the third ring. The dome is placed well back on the conical course and is only 7½ in. high at the center. A small auxiliary dome of cast steel is attached to the roof sheet over a 6-in. by 12-in. opening. This accommodates the safety valves.

The firebox is 132⅛ in. long by 96¼ in. wide inside the mud ring. The combustion chamber extends forward 54 in. into the shell ring. The firebox is of basic open-hearth steel and is fabricated completely by butt welding. This includes the tube sheet to the combustion-chamber shell, the inside throat-sheet seams, the longitudinal seams between the crown sheet and side sheets, the back head to the crown and side sheets, and the door-ring joint between the back head and door sheet.

Tate type D expansion stays are installed in the four longitudinal rows at each side of the crown sheet and





Elevation and sections of the M. St. P. & S. Ste. M. 4-8-4 type locomotive

in the four transverse rows over the top of the crown sheet at the front end of the combustion chamber. There are three longitudinal rows of flexible stays at the top of the side sheets adjacent to the flexible crown stays, two rows at the front and back ends of the side wrapper sheets and two outside rows around the back head. They are also filled in across the front and back top corners of the firebox. There is a complete installation in the throat sheet and around the barrel of the combustion chamber. All sleeves are threaded in the sheets.

The firebox is fitted with Firebar grates and the coal is fired by a Standard type BK stoker with the engine mounted near the front end of the tender on the left side.

The boiler is laid out for the Type E superheater, included in the header of which is the American multiple type throttle valve. The Tangential steam dryer is applied at the intake to the dry pipe. The feedwater heater is an Elesco steam-heat injector.

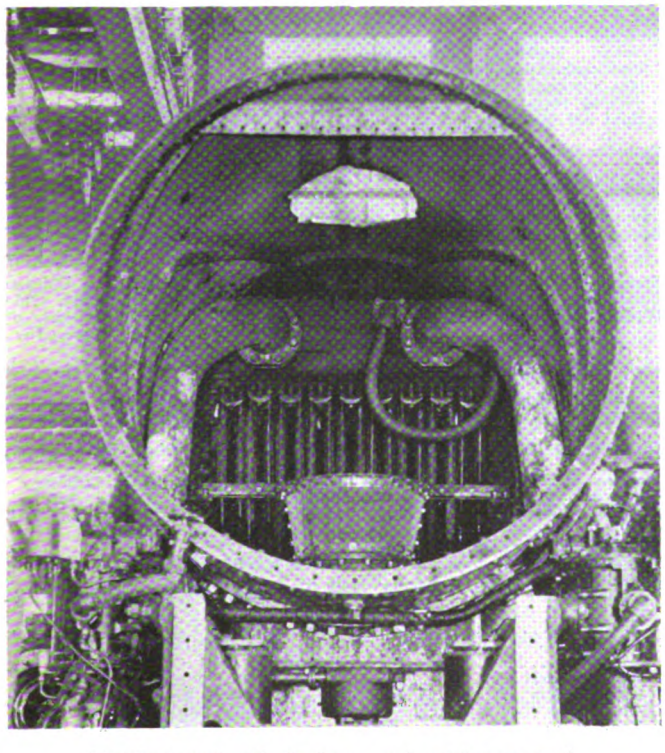
The locomotives have the Master Mechanics' front end. Both the front end and the ash pan are built to meet the requirements of the Minnesota State Forestry laws.

Frames and Running Gear

The foundation of the locomotive is a General Steel Castings bed, of which the cylinders and back cylinder heads are an integral part. The main reservoir is also cast integral with the bed, as are the air-compressor supports and the guide yoke and the reverse-gear bracket. The firebox is supported on expansion shoes, front and back. Waist sheets, attached directly to flanges of the bed casting, are placed in front of the front drivers, between the first and second pairs of drivers, and between the second and third pairs of drivers. The driving wheels have Boxpok cast-steel centers which are mounted on axles of medium carbon steel. The first pair is fitted with the Alco lateral motion device. The driving boxes are of the crown bearing type with Franklin grease cellars.

Both engine and trailer trucks were furnished by the General Steel Castings Corporation. The engine truck has inside bearings and cast-steel A. S. F. roller-bearing wheels. The trailer truck is of the four-wheel type with bronze journal bearings. The rear trailer wheels, which are 43 in. in diameter, have cast-steel centers; the others are of rolled steel.

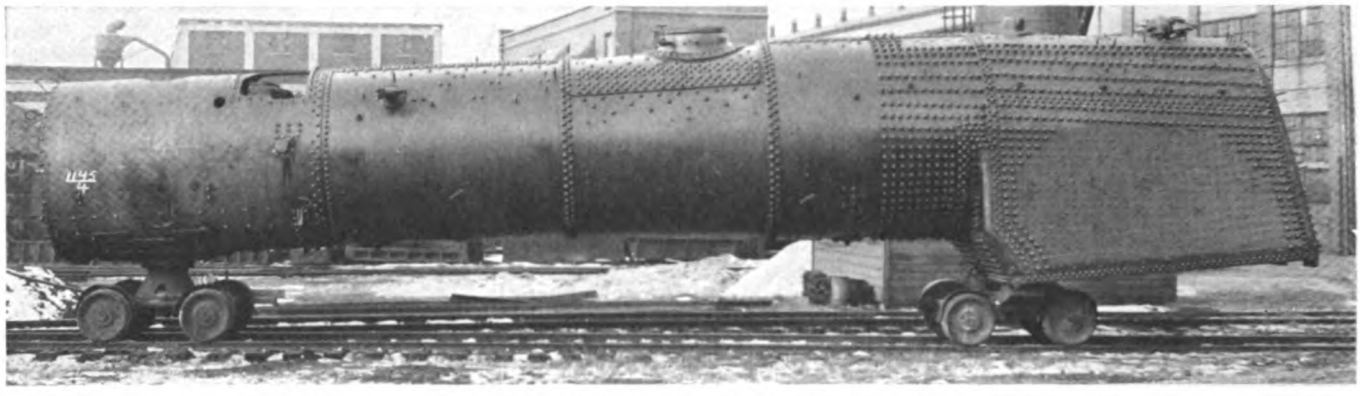
The pistons have cast-steel centers with bull rings of



The front end with diaphragm and netting removed

General Dimensions, Weights and Proportions of the M. St. P. & S. Ste. M. 4-8-4 Type Locomotives

Railroad	M. St. P. & S. S. M. (Wisconsin Central)
Builder	Lima
Type of locomotive	4-8-4
Road class	O-20
Road numbers	5000-5003
Date built	1938
Service	Freight and passenger
Dimensions:	
Height to top of stack, ft.-in.	15- 4½
Height to center of boiler, ft.-in.	10- 6
Width overall, ft.-in.	10- 9
Length overall, engine and tender, ft.-in.	101- 10⅝
Weights in working order, lb.:	
On drivers	263,000
On front truck	76,000
On trailing truck:	
Front axle	52,300
Rear axle	54,200
Total engine	445,500
Tender	317,600
Wheel bases, ft.-in.:	
Driving	19- 9
Rigid	13- 2
Engine, total	46- 9
Engine and tender, total	87- 9½
Wheels, diameter outside tires, in.:	
Driving	75
Front truck	36
Trailing truck:	
Rear	43
Front	36
Engine:	
Cylinders, number, diameter and stroke, in.	2-26x32
Valve gear, type	Walschaert
Valves, piston type, size, in.	12
Maximum travel, in.	7½
Steam lap, in.	1½
Exhaust clearance, in.	5/16
Lead in full gear, in.	1/8
Lead at 25 per cent cut-off, in.	7/16
Cut-off in full gear, per cent	82.7
Boiler:	
Type	Conical conn.
Steam pressure, lb. per sq. in.	270
Diameter first ring, outside, in.	86
Diameter largest, outside, in.	98
Firebox length, in.	132⅛
Firebox width, in.	96¼
Height mud ring to crown sheet, back, in.	77¾
Height mud ring to crown sheet, front, in.	93¼
Combustion chamber length, in.	54
Arch tubes, number and diameter, in.	5- 3½
Tubes, number and diameter, in.	65- 2¼
Flues, number and diameter, in.	199- 3½
Length over tube sheets, ft.-in.	21- 6
Net gas area through tubes and flues, sq. ft.	9.51
Fuel	Soft coal
Grate area, sq. ft.	88.3
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	376
Arch tubes	47
Firebox, total	423
Tubes and flues	4,719
Evaporative, total	5,142
Superheater	2,120
Comb. evap. and superheat.	7,262
Tender:	
Type	Water-bottom
Water capacity, gallons	17,500
Fuel capacity, tons	24
Trucks	6-wheel
Journals, diameter, in.	6½x12
Rated tractive force, engine 85 per cent, lb.	66,000
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	59.0
Weight on drivers ÷ tractive force	3.99
Weight of engine ÷ evaporation	86.64
Weight of engine ÷ comb. heat. surface	61.37
Firebox heat. surface, per cent comb. heat. surface	5.83
Tube-flue heat. surface, per cent comb. heat. surface	64.99
Superheat. surface, per cent comb. heat. surface	29.20
Firebox heat. surface ÷ grate area	4.79
Tube-flue heat. surface ÷ grate area	53.43
Superheat. surface ÷ grate area	24.05
Comb. heat. surface ÷ grate area	82.22
Gas area tubes and flues ÷ grate area	0.108
Evaporation ÷ grate area	747.30
Tractive force ÷ evaporation	12.83
Tractive force ÷ comb. heat. surface	9.09
Tractive force x diam. drivers ÷ comb. heat. surface	681.70



The completed boiler

Hunt-Spiller gun iron and Duplex sectional packing rings. The crossheads and guides are of the multiple bearing type. The latter are fitted with the Slidguide attachment to the back cylinder heads. Bronze floating bushings are mounted in all side rods and the back ends of the main rods, with fixed bushings of Hunt-Spiller gun iron.

The weight of the reciprocating parts on one side is 2,465 lb., 40.6 per cent of which is balanced. The overbalance amounts to 252 lb. in each front wheel; 220 lb. in each main wheel; 285 lb. in each intermediate wheel, and 245 lb. in each back wheel. At diametral speed the dynamic augment, from front drivers to rear drivers, amounts, respectively, to 12,700, 11,100, 14,400 and 12,400 lb.

The valve motion is of the Walschaert type designed for 7½ in. maximum travel and controlled by the Barco reverse gear. The valves are 12 in. in diameter. The body is a 5½-in. superheater flue with ends of boiler steel, Hunt-Spiller gun-iron bull rings, Duplex sectional packing rings and cast-steel followers.

Each locomotive is equipped with two U. S. Metallic Packing force-feed lubricators. One of these is a 24-pint Model 31-8, with four feeds, for valve oil. This supplies the valves and cylinders. The other is an eight-feed 32-pint Model 31-14, for car oil. One feed leads to the guides through a four-way divider and one to the valve-rod crosshead guides. Four feeds lead to the shoe-and-wedge faces of the driving boxes through a four-way divider, and two feeds supply the driving-box-hub faces through four-way dividers.

The side rods and back end main rods are equipped with Alemite hard-grease fittings. The valve gear, including the valve-rod crosshead pin, the spring rigging, the engine-truck center plate, and the radial buffer are

(*Continued on page 379*)

Partial List of Materials and Equipment on the M. St. P. & S. Ste. M. 4-8-4 Type Locomotives

Frames; engine truck; trailing truck; driving wheels, Boxpok	General Steel Castings Corp., Eddystone, Pa.
Engine-truck wheels; engine-truck roller-bearing units	American Steel Foundries, Chicago
Wheels, trailing truck	Edgewater Steel Co., Pittsburgh, Pa.
Tires; springs	American Locomotive Co., Railway Steel Spring Div., New York
Hub liner	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Lateral-motion device	American Locomotive Co., New York
Bumper	General Steel Castings Corp., Eddystone, Pa.
Coupler; coupler pocket	American Steel Foundries, Chicago
Radial buffer; driving-box cellars; Unit Safety drawbar	Franklin Railway Supply Co., Inc., New York
Brake equipment	Westinghouse Air Brake Co., Wilmerding, Pa.
Foundation brake	American Brake Co., St. Louis, Mo.
Lubricators	U. S. Metallic Packing Co., Philadelphia, Pa.
Grease fittings	Alemite Div. Stewart-Warner Corp., Chicago
Boiler shell	Lukens Steel Co., Coatesville, Pa.
Firebox sheet; front tube sheet	Otis Steel Co., Cleveland, Ohio
Staybolt iron	Ulster Iron Works, Dover, N. J.
Staybolts, flexible	Flannery Bolt Co., Bridgeville, Pa.
Tubes	Steel & Tubes, Inc., Cleveland, Ohio
Flues	National Tube Co., Pittsburgh, Pa.
Firebrick	Economy Arch Co., St. Louis, Mo.
Superheater and Tangential steam dryer	The Superheater Company, New York
Throttle	American Throttle Co., New York
Lagging	Johns-Manville Sales Corp., New York
Pipe covering	Union Asbestos & Rubber Co., Chicago
Pipe fittings	Crane Co., Chicago
Injectors:	
Right hand	Ohio Injector Co., Wadsworth, Ohio
Left hand (exhaust steam)	The Superheater Company, New York
Steam gages; safety valves	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Blow-off cocks	The Okadee Company, Chicago
Mufflers	Wilson Engineering Corp., Chicago
Washout plugs	The Prime Manufacturing Co., Milwaukee, Wis.
Stoker	Standard Stoker Co., Inc., New York
Firedoor	Franklin Railway Supply Co., Inc., New York
Netting, smokebox	The W. S. Tyler Co., Cleveland, Ohio
Grate	Waugh Equipment Co., New York
Slidguide attachment	American Locomotive Co., New York
Cylinder bushings; piston-valve bushings; piston bull rings; Duplex sectional cylinder and valve packing rings; valve bull rings; fixed rod bushings	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Cylinder cocks	U. S. Metallic Packing Co., Philadelphia, Pa.
Water column	Nathan Manufacturing Co., New York
Water gage	The Okadee Company, Chicago
Low-water alarm	Barco Manufacturing Co., Chicago
Back-pressure gage	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Steam-heat regulator	Vapor Car Heating Co., Inc., Chicago
Steam pipe casing (Reid)	Lima Locomotive Works, Lima, Ohio
Whistle	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Bell ringer	Viloco Railway Equipment Co., Chicago
Headlights; dynamo	Pyle-National Co., Chicago
Sanders	Graham-White Sander Corp., Roanoke, Va.
Classification lamp	The Adams & Westlake Co., Elkhart, Ind.
Reverse gear	Barco Manufacturing Co., Chicago
Piston-rod valve-stem packing	Paxton-Mitchell Co., Omaha, Neb.
Air-pump lubrication	Westinghouse Air Brake Co., Wilmerding, Pa.
Flexible joints; piping between engine and tender	Barco Manufacturing Co., Chicago
Tender:	
Water-bottom frame	General Steel Castings Corp., Eddystone, Pa.
Trucks	Buckeye Steel Castings Co., Columbus, Ohio
Wheels	Edgewater Steel Co., Pittsburgh, Pa.
Side bearings	A. Stucki Co., Pittsburgh, Pa.
Clasp brakes	American Steel Foundries, Chicago
Draft gear	W. H. Miner, Inc., Chicago
Tank valve	Everlasting Valve Co., Jersey City, N. J.
Strainer	T-Z Railway Equipment Co., Chicago

Locomotive Axle Testing*

Data from accelerated tests on 11½-in. and 2-in. axles indicate bending stresses which cause development and propagation of fatigue cracks in wheel seats while in service

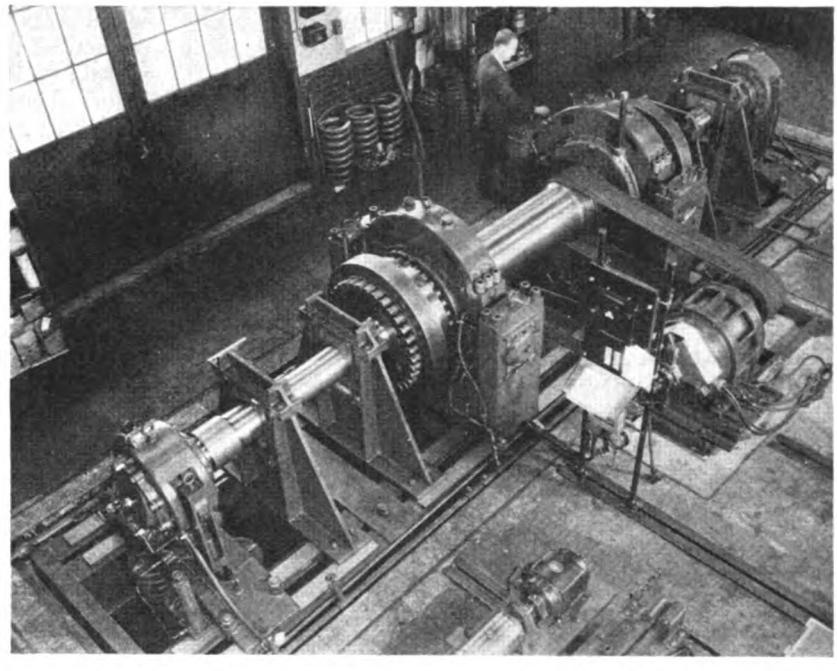


Fig. 1—Timken testing machine for locomotive driving axles

In view of the importance of fatigue cracks which develop in the wheel fit of axles in service, the Timken Roller Bearing Company initiated over a year ago a program of laboratory fatigue tests on outboard-bearing electric-locomotive axles 11½ in. in diameter at the wheel seat. The machine used in making these tests is designed so that two axles may be tested simultaneously as cantilever beams at the same or different bending stresses, one test axle-and-wheel assembly being located at each end of the machine as shown in Fig. 1. Constant vertical spring load is applied at the journal end of the axle opposite the end on which the wheel is mounted. The entire axle-and-wheel assembly is bolted to a rotating flange by means of 34 bolts at the rim of the wheel. The journal end of the axle protruding beyond the pressed-on wheel projects into the test-machine spindle which is hollow bored; there is no contact between the spindle and the axle-and-wheel assembly except at the bolted rim of the wheel. A 100-hp. variable-speed motor drives the machine through an eight-strand V-belt connected to the central drive shaft located between the two rotating flanges to which the axle-and-wheel assemblies are bolted.

The accelerated test made with this machine produces axle fatigue fractures which have exceptionally close similarity to axle failures developed in service in that (a) the location and type of fatigue fractures in the wheel seat near the inside hub face in test axles are comparable with results in service; (b) initial development of a fatigue crack in test axles is produced at very low axle bending stress, but does not have appreciable progagation unless occasional high stresses are produced; a similar condition is found in service with ordinary speed equipment when magnetic examination is made of used axles before returning for new wheels; and (c) axles stresses at which the incipient fatigue cracks mentioned in (b) propagate to appreciable depth and then to complete failure of the test axle compare favorably with service experience with high-speed equipment where higher occasional stresses would be experienced.

Various Phases of Axle Failure

It has been found in the course of the tests made to date that, for press-fitted wheel-and-axle assemblies, it is not sufficient to determine the usual *S-N* curve showing the life, in miles or revolutions, at which the axle breaks off at a given stress and the maximum below which the axle will not break off. So that the reader may better understand the reasons for obtaining more

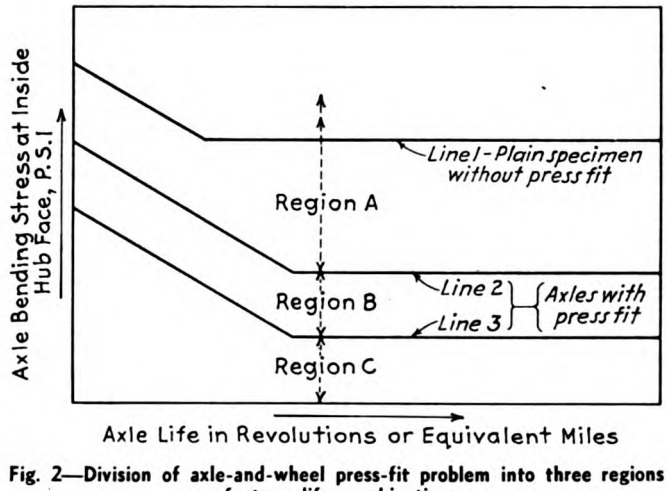


Fig. 2—Division of axle-and-wheel press-fit problem into three regions of stress-life combinations

* Abstracted from the paper "Locomotive Axle Testing," by T. V. Buckwalter, vice-president, O. J. Horger, research engineer, and W. C. Sanders, general manager, railway division, Timken Roller Bearing Company. The paper was published in the May, 1938, issue of the A.S.M.E. Transactions and presented at the semi-annual meeting of the American Society of Mechanical Engineers at St. Louis, Mo., June 21, 1938.

than the usual number of data in these tests, a brief explanation will be given of the logic followed in the pursuit of this problem.

Line 1 in Fig. 2 represents the usual *S-N* curve for an axle without a press fit and indicates that the plain axle will not break off for conditions of stress and life

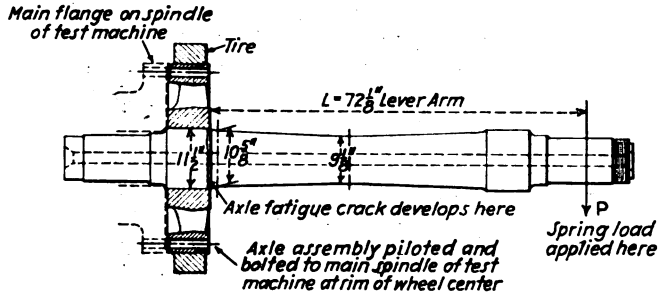


Fig. 3—Details of axle-and-wheel assembly tested in the fatigue machine

below this curve. The flat portion of this curve corresponds to a stress below which the axle will not break off; apparently, this is also the limiting stress below which the axle will not crack. In other words, when a crack begins in a plain specimen, it will eventually propagate to complete failure or breaking off of the axle if the stress is not reduced.

For a press-fitted wheel-and-axle assembly such as that shown in Fig. 3, conditions are different than for a plain specimen and it is necessary to determine, from tests, (a) the stress and life conditions at which the first fatigue crack develops, (b) the rate of propagation of fatigue cracks to the point where the axle breaks off, and (c) the conditions under which there occurs the phenomenon of formation of fatigue cracks which progress only to a certain depth and stop propagating. The interpretation of the foregoing is shown graphically in Fig. 2 where the *S-N* curves for press-fitted axles divide the axle life into three regions, *A*, *B* and *C*, separated from each other by lines 2 and 3. Line 2 represents the fatigue strength of the axle with a press-fitted wheel and indicates that the axle will break off before reaching stress and life combinations above the line which is region *A*. Line 3 also applies to press-fitted assemblies and predicts that the fatigue crack will be initiated for stress and life conditions just above line 3 but will not propagate to a point where the axle breaks off unless the stress is increased above line 2.*

Summarizing, we therefore have three phases into which the axle press-fit problem may be divided: Region *A*—Axle breaks off in wheel fit. Region *B*—Axle develops fatigue cracks in wheel fit which will not propagate to cause breaking off of the axle unless the stress is increased above line 2. Region *C*—No fatigue cracks develop.

In order to obtain this complete information in Fig. 2 it becomes necessary to test several axle assemblies at the same stress for various life conditions. This procedure requires a great number of tests. The cost and time required to make these tests on full-size axles are limited; thus, miniature-axle tests give a means of minimizing the number of large-axle tests.

* H. F. Moore in his article "A Study of Fatigue Cracks in Car Axles," Bulletin No. 165, University of Illinois Experiment Station, June 14, 1927, found that incipient fatigue cracks which had already been developed in plain rotating-beam specimens cut from axles did not propagate at bending stresses of about 50 per cent of the endurance limit of the virgin material. These results may help to explain the phenomenon of initiation of fatigue cracks which do not propagate in the hub fit of press-fitted axles because the stresses represented below line 2 shown in Fig. 3, are less than 50 per cent of the endurance limit of the plain specimen.

The various phases of axle failure exhibited in Fig. 2 were developed experimentally from the results of tests on 2-in. axles to be described later. It is also believed that these curves have practical significance due to the fact that service experience with ordinary-speed equipment indicates incipient cracks have developed in axle wheel seats, suggesting operating conditions in the lower portion of region *B* where a large number of stress reversals of low magnitude are produced. It is only on higher-speed equipment that these cracks show propagation as a result of occasional high stresses, thereby simulating the upper portion of region *B*, and crossing into region *A* where the axle actually breaks off.

This division of axle failures has been recognized for some time by the authors but never published due to lack of sufficient number of tests to establish this method of analysis as will be done in this paper. Lines 1 and 2 of Fig. 2 involve no new thoughts on this problem over previous tests reported in the literature, but line 3 presents new conditions which are believed to have considerable practical importance for the cases where wheel flange thrust is present. If no flange thrust were present, then the sloped portion of line 3 would remain substantially as shown, but the lower flat portion would coincide with the similar portion of line 2. (The authors, however, do not wish to imply that lines 2 and 3 for this case would coincide with line 2 for the type of test assembly shown in Fig. 3.) This belief is borne out by the fact that, in tests where the pressed-on hub was not restrained in any way except by its press fit on the axle, no fatigue cracks could be detected in axles which had been tested through a long life without breaking off. Thus, it would appear that, for an axle with a press-fitted hub, the stress below which the axle will not crack is the same as the stress below which the axle will not break off—just as in the case of a plain specimen with no press fit—provided there is no bending moment taken through the hub, i.e., no thrust forces acting on the hub. Flange thrust develops crushing and shearing stresses in the wheel fit which apparently are responsible for the formation of cracks which do not propagate in the lower region *B*. Since it is the practice of railroads to discard a cracked axle when detected during an inspection, the practical effect of flange thrust is to lower the endurance limit from line 2 to line 3, shown in Fig. 2.

All the bending moment in the laboratory test axle is taken through the wheel fit, giving a condition somewhat more severe than those occurring in railway service. For this reason, the actual location of line 3 determined in these tests may be a little lower than service conditions would give.

Description of 11½-In. Axles Tested

Fig. 3 is a line drawing of the axle-and-wheel assembly tested, which has dimensions identical with those of axles used in service. This is also true of the wheel, except the length of the spokes has been shortened; however, the sections of the hub, rim, spokes and shrunk-on tire are the same as used in service.

All the axles used for the tests were obtained from the same heat, and all axle forgings were given a normalizing and tempering treatment to produce the actual measured physical properties given in Table I, which also includes the chemical analysis. A 2-in. diameter hole was drilled through the center of all the axles. All axles assemblies, as shown in Fig. 3, were furnished by the Pennsylvania completely machined, assembled and ready for test.

The cast-wheel centers used were of A. A. R. grade C steel and were pressed on the axle in accordance with

standard railroad practice. The mounting tonnages and diameter fits are given in Table II. A steel tire of 3¾-in. by 6-in. section was shrunk over each cast-steel wheel center after the center had been mounted on the axle

Table I—Chemical Analysis and Physical Properties of Axles Tested

	11½- and 2-in. axles of low-carbon nickel	2-in. axles of S.A.E. 1045 steel
Chemical analysis:		
Carbon, per cent	0.24	0.450-0.490
Nickel, per cent	3.10	0.040-0.060
Sulphur, per cent	0.02	0.031-0.037
Phosphorus, per cent	0.03	0.013-0.017
Manganese, per cent	...	0.670-0.770
Physical analysis:		
Yield point, lb. per sq. in.	60,950-69,000	47,800
Ultimate strength, lb. per sq. in.	91,000-94,900	88,800
Elongation in 2 in., per cent	25.0-30.0	32
Reduction of area, per cent	67.5-70.6	48.5
Brinell hardness	192	177
Fatigue strength, ¼-in. diameter rotating beam, lb. per sq. in.	55,300	34,400 (2 in. diam.)

as a means of nearly simulating the service assembly. The tire fit was 1/64 in. per ft. of wheel-center diameter.

Two uncompleted series of tests are reported in this paper, one series being on rolled axles while the other is on unrolled axles. The wheel-fit portions of the unrolled axles were given a smooth turned finish. The so-called rolled axles were surface-rolled (burnished) over the entire wheel fit portion before the wheel center was mounted on the axle, for the purpose of investigating what increase in strength would result. In the rolling process the axle was rotated on lathe centers at 25 to 50 r. p. m. while the rollers were fed along the axle by the lathe carriage at the equivalent rate of about 28 threads per inch. The rolling device consists of three rollers spaced 120 deg. apart and the pressure used was 25,000 lb. per roller. Roller dimensions were 10 in. diameter by 1½ in. contour radius.

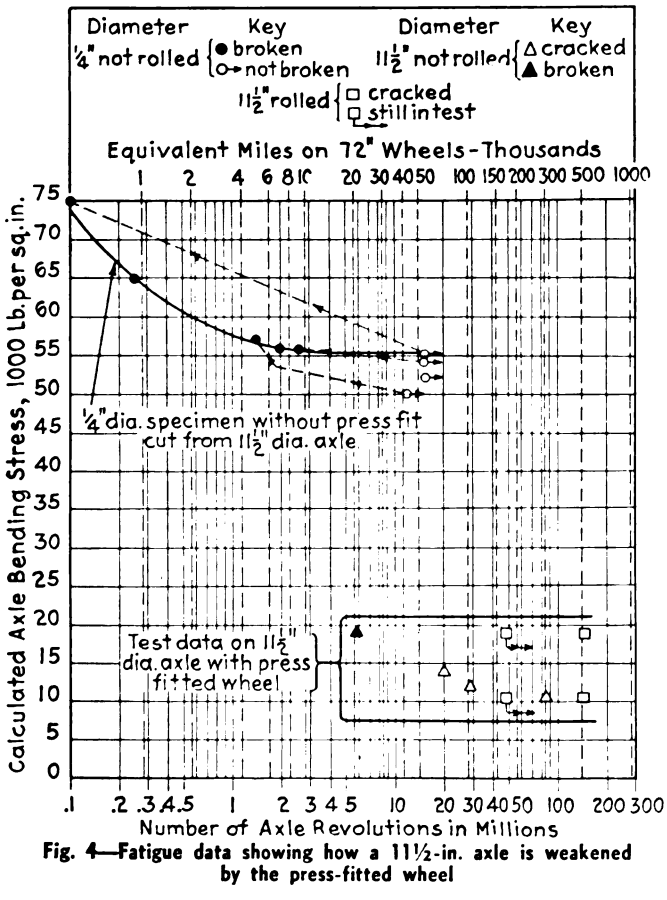


Fig. 4—Fatigue data showing how a 11½-in. axle is weakened by the press-fitted wheel

The rolled axles were given a ground finish previous to rolling. The reduction in diameter due to rolling was 0.001 to 0.002 in. Axles other than those tested have been rolled using a smooth turned surface, and in such cases the reduction is 0.003 to 0.005 in. Since practically all this reduction takes place locally on the surface, the character of the machined surface controls the change in diameter due to rolling.

Description of Two-Inch Axles Tested

Scale-size model tests were made of the full-size nickel-steel axle-and-wheel assemblies. These axles were machined from the outer layers of the full-size axles. A cast-steel wheel center, A. A. R. grade C, having no spokes or tire was pressed on the axle which had a 2-in. diameter raised wheel seat. The fundamental design of these machines, as well as the principle and technique of testing is the same as for the large machine shown in Fig. 1.

Carbon-steel axles of 2 in. diameter were also tested in the same manner as the 2-in. diameter nickel-steel

Table II—Summary of Axle Fatigue-Test Data

Axle No.	Wheel fit on axle, in.	Wheel mounting tonnage	Axle bending stress, lb. per sq. in.	Life to failure: Number of revolutions	Life to failure: Equiv. miles‡	Max. depth of crack, in.
			Unrolled Nickel Steel			
9545*	0.017	162	19,000	5,727,000	20,500	49/16
9540*	0.016	152	14,000	19,850,000	70,600	13/32
9549*	0.016	135	12,000	28,680,000	102,200	23/64
9550*	0.016	170	10,500	83,730,000	298,000	1/16
			Rolled Nickel Steel			
9555*	0.0135	178	19,000	143,470,000	510,500	7/16
9553*	0.013	174	10,500	140,500,000	500,000	1/64
9554†	0.012	192	19,000	48,500,000	172,800	...
9542†	0.013	205	10,500	48,500,000	172,800	...

* Failed.
† Still being tested.
‡ Obtained by converting number of revolutions into locomotive miles on the basis of 72-in. diameter drivers. This conversion given for convenience only and does not mean that miles and revolutions given are necessarily equal.

axles. These tests on carbon-steel axles have been under way for several years and were originated before those on nickel steel. For this reason the design of the carbon-steel axle is not the same as the one made of nickel steel.

S. A. E. 1045 steel was used for these axles, cut from hot-rolled 2¼-in. round bar stock normalized and tempered to give the actual physical properties and chemical composition listed in Table I.

Results and Discussion of Tests on 11½-In. Axles

Table II gives a summary of the fatigue-test data for eight full-size axles. The usual *S-N* data showing axle life is shown in Fig. 4. Some illustrations of axle failures, all of which occurred within the axle wheel fit, are shown in Figs. 5 to 10, inclusive. Some explanation may be necessary as to the manner in which specimens shown in Fig. 6 were obtained. A transverse slice was first sawed from the axle wheel seat containing the fatigue crack. This slice was then sawed into six pie-shaped segments, after which each segment was further sawed into the plane of the fatigue crack and the final separation developed by wedging apart the two portions of each segment through the saw cut. Therefore, Fig. 6 shows the saw-cut marks in the center of the axle, the area broken by wedging, and the fatigue crack developed in test which may be identified at the outer circumference of the axle.

None of the full-size axles were run until the axle



Fig. 5—Fatigue crack in the wheel seat of unrolled axle No. 9545

Test axle No. 9545 of 3.1 per cent nickel and 0.24 per cent carbon steel, normalized and tempered. The bending stress at the inside hub face was 19,000 lb. per sq. in. The axle was tested to 5,727,000 revolutions to failure, which is equivalent to 20,500 miles on 72-in. wheels.

The fact that unrolled axle No. 9550 shows fatigue cracks at such low bending stresses as 10,500 lb. per sq. in., indicates that line 3 of Fig. 2 will be below this value. Failure at this low stress indicates that the press fit of the wheel gives less than one-fifth of the fatigue strength available in the axle without a press fit. This statement is based upon the data in the *S-N* curves of 4, where the fatigue strength of plain specimens, ¼ in. diameter without a press fit and cut from the outer layers of one of the large axles, was found to be about 55,000 lb. per sq. in.* It is expected that the fatigue strength for plain specimens of a large diameter, when they are tested later in the program, will be less than that found on the ¼-in. diameter specimens.

A comparison between the test results of rolled and unrolled axles for the same bending stress is shown in Table III. While both kinds of axles developed fatigue cracks, the depth and propagation of the cracks in the rolled axle is much slower than in the unrolled axle. At the high bending stress of 19,000 lb. per sq. in., the

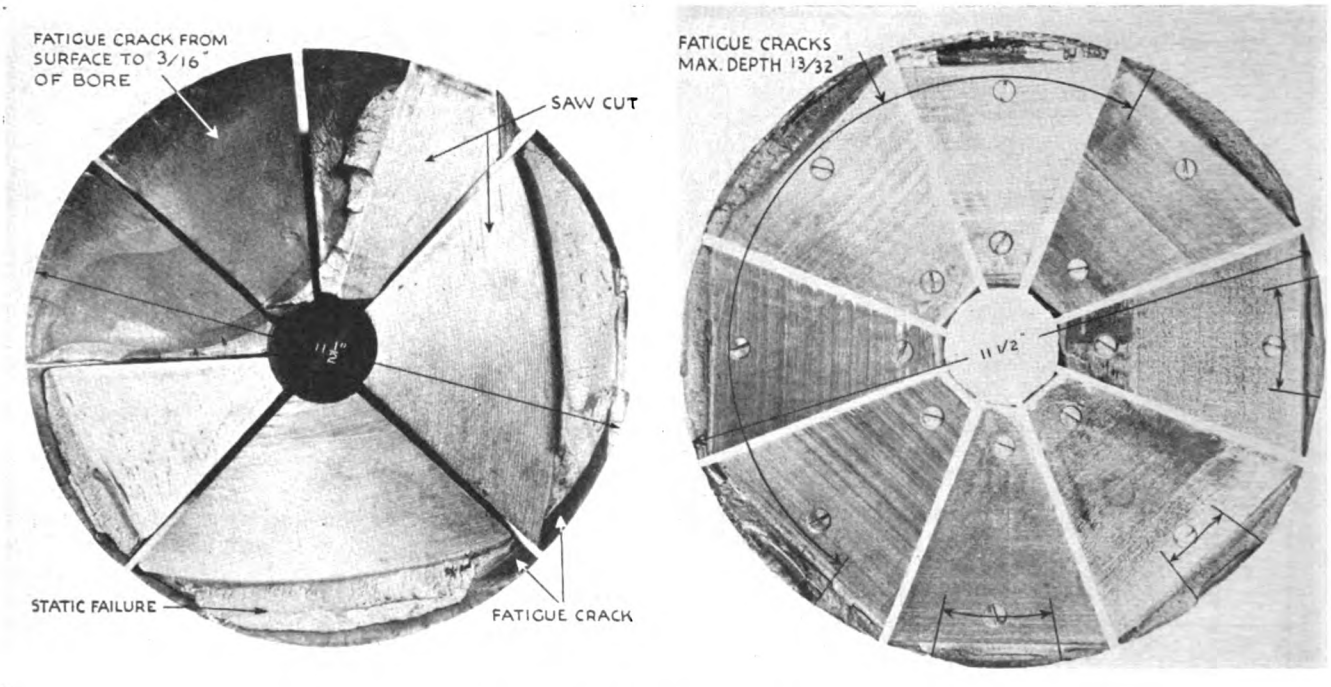


Fig. 6—Depths of fatigue cracks in the wheel seat of unrolled axles Nos. 9545 and 9540

Left: Depth of fatigue cracks in axle No. 9545 shown in Fig. 3; compare the depth of this crack with that developed in the rolled axles tested at the same stress, but with twenty-five times the life, as shown in Figs. 7, 8 and 9—Right: Cracks developed in the wheel seat of unrolled axle No. 9540 near the inside hub face; this axle like all the others was of 3.1 per cent nickel and 0.24 per cent carbon steel, normalized and tempered. The bending stress at the inside hub face was 14,000 lb. per sq. in., and was tested to 19,850,000 revolutions to failure, which is equivalent to 70,000 miles on 72-in. wheels.

broke off in the test machine, although unrolled axle No. 9545, shown in Figs. 5 and 6 (left), was very close to this condition. The fatigue crack extended from the circumference practically into the hole through the center of the axle.

Insufficient tests are shown in Table II to determine the complete set of axle-failure curves outlined in Fig. 2, but the individual axle tests are plotted in Fig. 4. The test of unrolled axle No. 9540, at a bending stress of 14,000 lb. per sq. in., may indicate from the $^{13}/_{32}$-in. deep fatigue crack in Fig. 6 (right), that the axle would break off at about this stress. This is to say that line 2 of Fig. 2 will fail at about 14,000 lb. per sq. in., but this inference must be substantiated by tests to be made later.

Table III—Comparison of Rolled and Unrolled Axles

	Axle life		Maximum depth of crack, in.
Axle bending stress of 19,000 lb. per sq. in.:	No. of Revolutions	Equiv. miles	
1—Unrolled	5,737,000	20,500	4⁹/₁₆
2—Rolled	143,470,000	510,500	⁷/₁₆
3—Ratio of values in line 2 to those in line 1	25	25	¹/₁₀
Axle bending stress of 10,500 lb. per sq. in.:			
4—Unrolled	83,700,000	298,000	¹/₁₆
5—Rolled	140,500,000	500,000	¹/₆₄
6—Ratio of values in line 5 to those in line 4	1.7	1.7	¼

* The actual fatigue tests on these ¼-in. plain specimens were made in the conventional R. R. Moore rotating-beam machine by the International Nickel Company from machined specimens furnished by the authors.

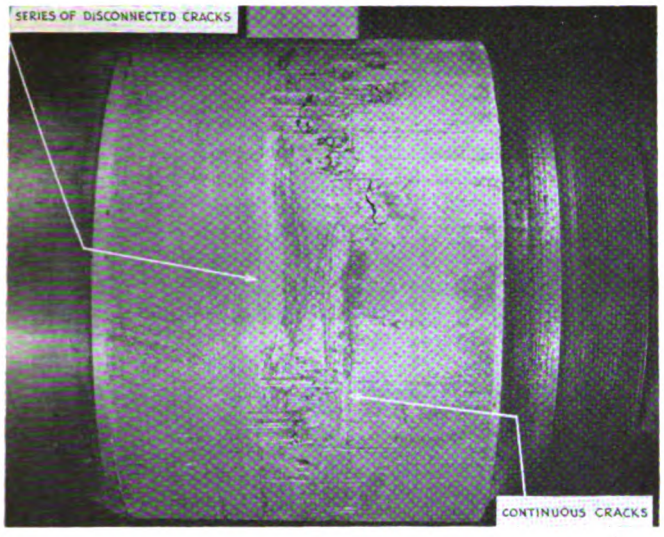


Fig. 7—Fatigue cracks developed in the wheel seat of rolled axle No. 9555

Test axle No. 9555 of 3.1 per cent nickel and 0.24 per cent carbon steel, normalized and tempered. The bending stress at the inside hub face was 19,000 lb. per sq. in. The axle was tested to 143,470,000 revolutions to failure, which is equivalent to 510,000 miles on 72-in. wheels. The fit of the axle was completely lost except for 2 in. near the center of the wheel seat, but the dismounting pressure was 600 tons with the rim of the wheel heated.

crack in the rolled axle is only one-tenth as deep after about 25 times the life of the unrolled axle. At 10,500 lb. per sq. in., the rolled axle had a crack about one-quarter as deep after about 1.75 times the life of the unrolled axle.

The previously mentioned tests on rolled axles are now in the process of being checked by axles running in the machines at the present time as indicated in Table II. While these check tests are not completed, they are sufficiently advanced to justify the feeling of similar improvement over unrolled axles.

The test of the rolled axle at 19,000 lb. per sq. in. represents a very severe test and one which will not be equalled under any service conditions, inasmuch as the wheel entirely lost its fit on the axle except for about 2 in. near the center of the fit. This loss of fit is due to a mechanical action of rubbing corrosion caused by the minute sliding or molecular attrition of the axle in the wheel fit occurring during each revolution. The mutilated surface of the axle wheel fit is apparent from Figs. 7 and 8 and even though only about a 2-in. length of fit remained, 600 tons presure was not sufficient to press the wheel off the axle at the end of the test. It was necessary to heat the rim of the wheel and at the same time press on the axle to dismount the wheel at 600 tons.

Fig. 8 shows segments about 1¼ in. thick cut from the surface layers of the entire length of wheel seat of the axle shown in Fig. 7. These segments have been bent to open through the fatigue cracks. The depth of the fatigue cracks is indicated in Fig. 9. The development of the series of fatigue cracks, shown in Figs. 8 and 9, instead of the usual single circumferential crack may be explained by the shortening of the wheel fit during the progress of the test.

The fact that the rolled axle also showed a crack at the low stress of 10,500 lb. per sq. in. checks with tests on 2-in. minature axles to be discussed later. It was found that the incipient fatigue cracks in rolled axles developed at a stress which is about the same as, or slightly higher than, the stress at which they occur in unrolled axles, but these cracks propagate at a much slower rate in the rolled axles.

Additional tests are scheduled for rolled axles at much higher stress than used previously to simulate the effect of a large number of occasional stresses of high value in service.

The practical value of the rolled axle is that considerably increased strength is obtained over the unrolled axle and the liability of the axle breaking off in road service is reduced. As more test data are accumulated on full-size rolled axles, and if improved strength will be reflected comparable to that for 2-in. axles which were also tested, it is believed that the present typical mileage limit of 250,000 to 300,000 miles, at which driving axles are scrapped, may be increased to as much as possibly 500,000 to 1,000,000 miles, especially when rolling is combined with a higher raised wheel seat and possibly



Fig. 8—Segments from the wheel seat of axle 9555 shown in Fig. 5, bent slightly to open the cracks

The fatigue cracks run circumferentially in the axle shown in Fig. 7. The actual depths of the cracks are shown in Fig. 9.

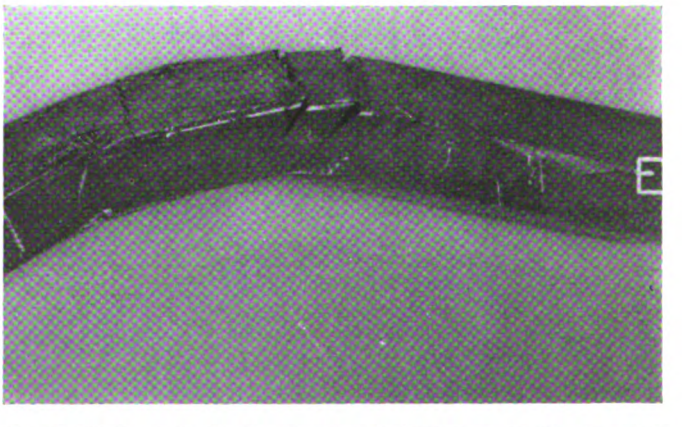


Fig. 9—Maximum depth of cracks in axle 9555 shown in Figs. 5 and 6

Maximum depth of cracks was 7/16 in. Note how the crack propagates at an angle of about 45 deg. with the surface. Compare these cracks with those in unrolled axle No. 9545 shown in Fig. 6.

relief grooves in the hub of the wheel. The results of unpublished tests on unrolled axles, designed with a higher raised wheel seat than is reported in these tests, indicate that considerable improvement may be expected from this feature alone.

These tests on full-size locomotive driving axles are being continued and further progress reports will follow at a later date. It should also be mentioned that two additional axle-testing machines of the type shown in Fig. 1 are also in operation in the laboratory of the Timken Roller Bearing Company since December, 1937, on tests of 5½-in. by 10-in. passenger-car axles. This latter program is under the direction of the Association of American Railroads.

Results and Discussion of Tests On 2-In. Miniature Axles

The 2-in. axles machined from the outer layers of the large axles were tested and the results are plotted in the *S-N* curves of Fig. 11. The fatigue strength for breaking off of the axle is indicated by line 2 as being 17,500 lb. per sq. in., and that for no development of cracks as 10,000 lb. per sq. in. in line 3. The practical meaning of these two curves applied to 2-in. axles is, as mentioned before, that 10,000 lb. per sq. in. is a safe value to use for design purposes so that no cracks will develop under conditions of high occasional flange thrust. If stresses higher than 10,000 lb. per sq. in. are produced, the fatigue cracks will not progress to the point of the axle breaking off unless occasional bending stresses above 17,500 lb. per sq. in. are developed. Sufficient tests have not been made to date to complete the sloped portion of line 3 showing when the crack is first initiated under service conditions of high occasional stresses.

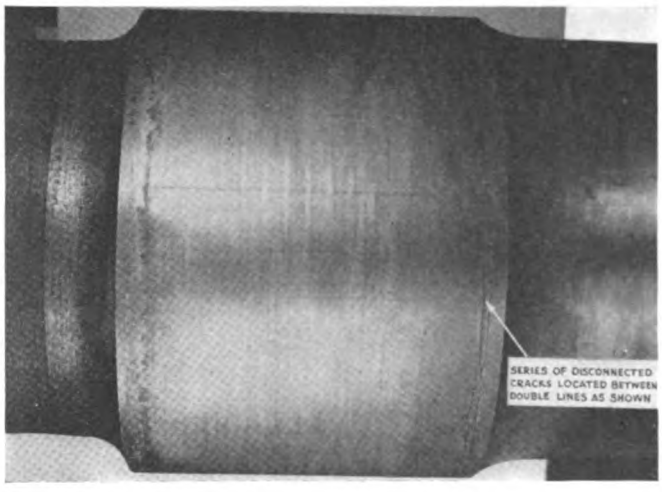


Fig. 10—Fatigue cracks in rolled axle No. 9553

Test axle No. 9553 of 3.1 per cent nickel and 0.24 per cent carbon steel, normalized and tempered. The bending stress at the inside hub face was 10,500 lb. per sq. in. The axle was tested to 140,500,000 revolutions to failure, which is equivalent to 500,000 miles on 72-in. wheels.

The wheel fit on the unrolled axle of these tests on 2-in. axles varied between 0.0025 and 0.0030 in. Only the data on unrolled axles are shown in Fig. 11, although sufficient tests have been made on rolled axles to give preliminary indications. With rolled axles, line 2 in Fig. 11 will be at least twice as high i.e., 35,000 lb. per. sq. in. instead of 17,500 lb. per sq. in., and line 3 will be about 10,000 lb. per sq. in. as before. The practical interpretation of this difference between rolled and unrolled axles is that the rolled axle has much greater resistance to crack propagation and will withstand much higher occasional stresses in service without danger of the axle breaking off.

A tentative comparison as given in Table IV may be made between the fatigue-strength values in Figs. 4 and 11 obtained for the 11½-in. and 2-in. diameter unrolled axles, to show the influence of "size effect." This tentative comparison creates the opinion that the designer must use lower allowable stresses when dealing with the large sections used in these tests.

The foregoing discussion applies to the use of low-carbon nickel steel, and, since plain-carbon steels are ordinarily used in railroad service, a brief reference will be made to the results of tests on 2-in. axles of this steel.

Figs. 12 and 13 show *S-N* curves for 2-in. unrolled and rolled axles, respectively. The same general com-

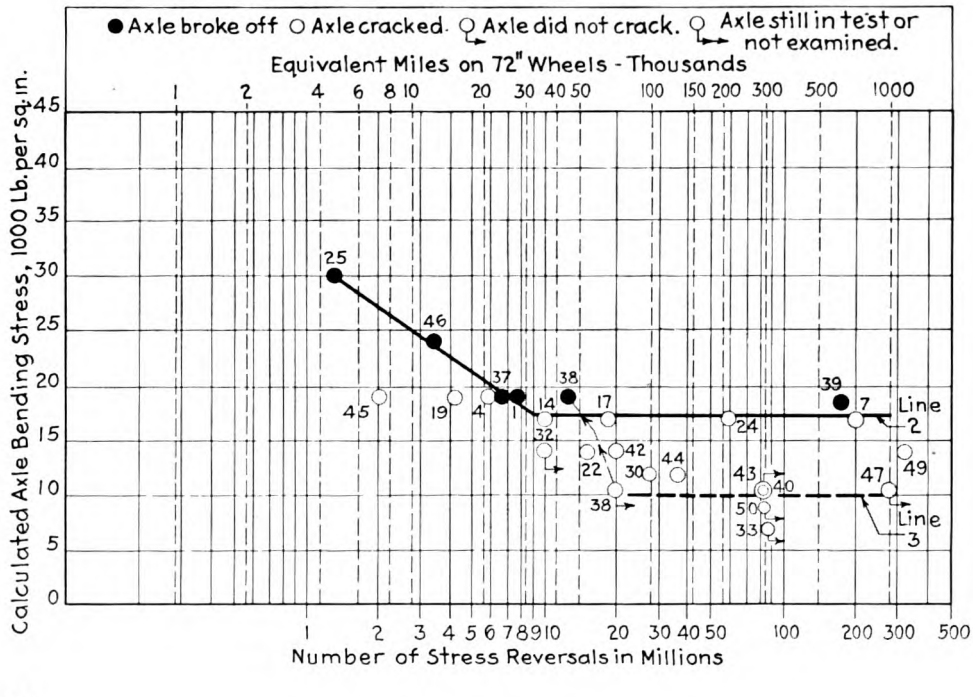


Fig. 11 — *S-N* curves of 2-in. diameter scale-size Pennsylvania P-5-a driver axles — surface not rolled

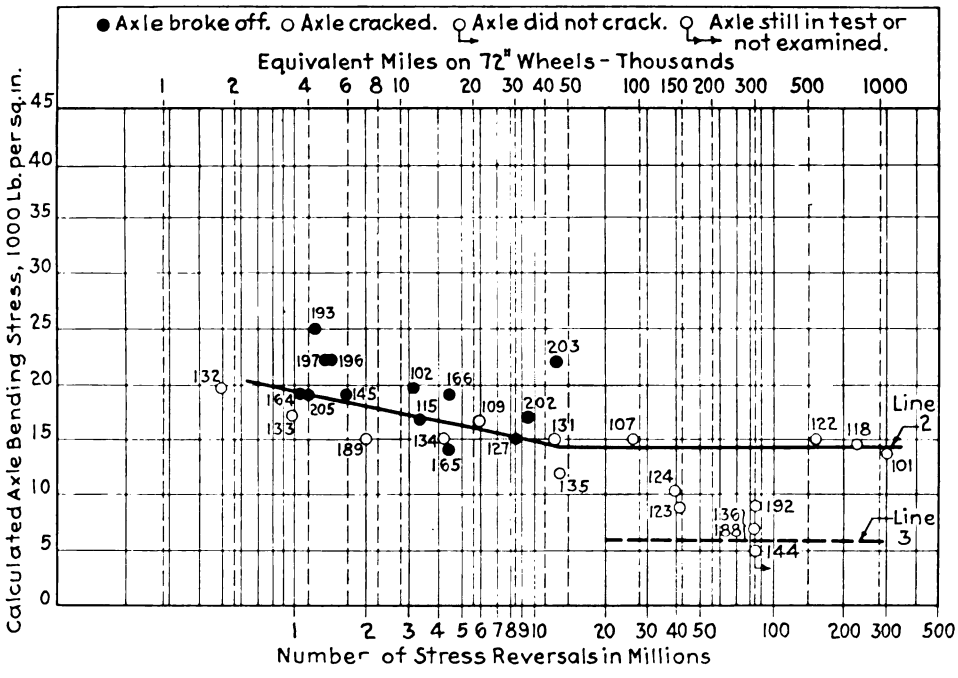


Fig. 12—*S-N* curves of unrolled 2-in. diameter scale-size axles of S.A.E. 1045 carbon steel

ments given for the previously mentioned tests on 2-in. axles, using nickel steel, apply also to these curves. In making a comparison between the tests of carbon-steel and nickel-steel axles, however, it should be mentioned that the raised seat used on the nickel-steel axles represents an improvement in design over the carbon-steel axle without the raised seat. With this in mind, we find that the breaking-off value for the carbon-steel axle is 14,000 lb. per sq. in. as against 17,500 lb. per sq. in. on the nickel-steel axle; also, the development of the crack in carbon-steel axles is initiated at about 6,000 lb. per sq. in. as against 10,000 lb. per sq. in. on the nickel-steel axles.

Table IV—Influence of Axle Size on Fatigue Strength

Axle diameter, in.		1 1/4	2
Axle broken off, line 2 (Fig. 2), allowable bending stress, lb. per sq. in.	Possibly	14,000	17,500
No development of fatigue cracks, line 3 (Fig. 2), allowable bending stress, lb. per sq. in.	Less than	10,500	10,000

The quantitative influence of the raised seat is not known, but some material improvement may be expected by its use to account for a part of the differences which have been previously mentioned.

Reference should be made to Fig. 13 indicating that rolling increased the breaking off fatigue strength of the unrolled axle from 14,000 lb. per sq. in. as shown in Fig. 12, to 35,000 lb. per sq. in., or 2.5 times. Little improvement is shown for the stress at which incipient fatigue cracks take place as this value is 7,500 lb. per sq. in. for the 2-in. diameter rolled carbon-steel axle and 6,000 lb. per sq. in. for the unrolled axles.

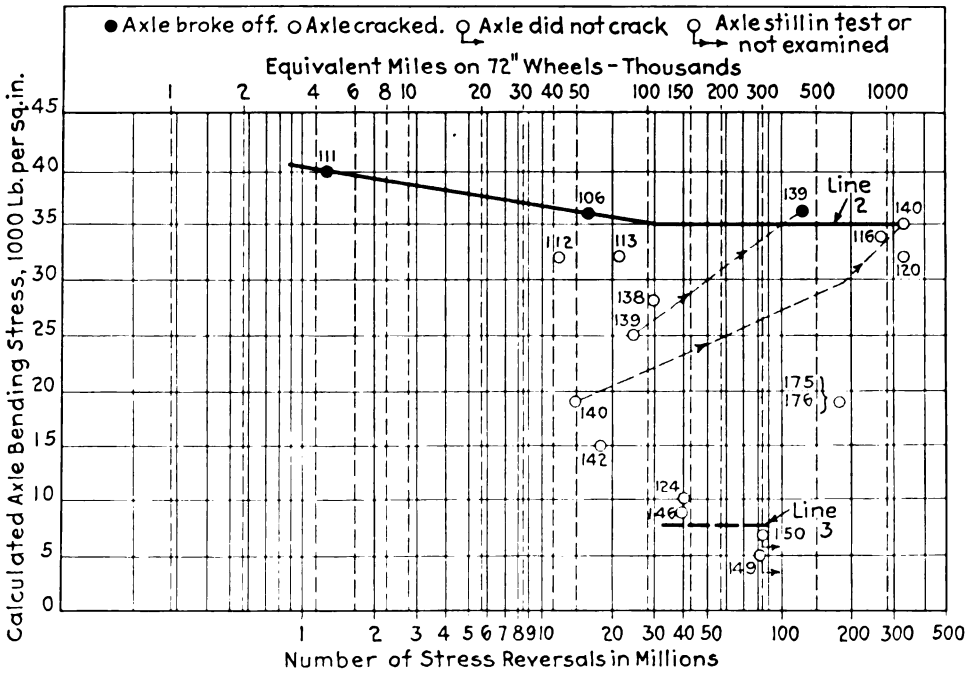
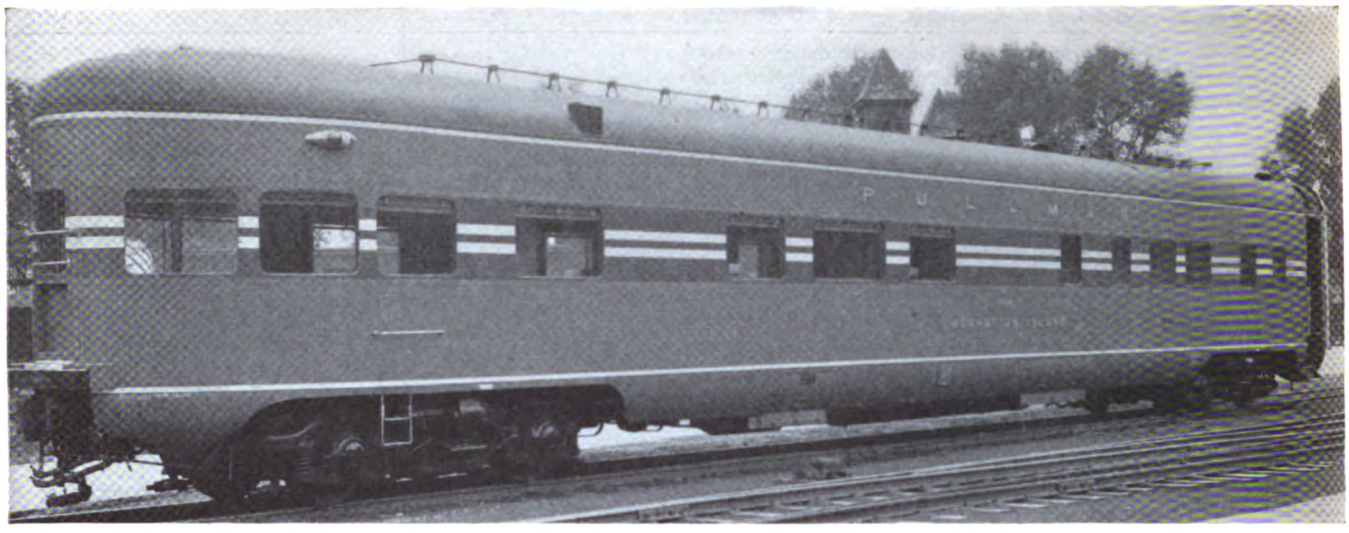


Fig. 13—*S-N* curves of rolled 2-in. diameter scale-size axles of S.A.E. 1045 carbon steel
Surface rolled at 2,400-lb. pressure per roller. The rollers were 2.916 in. diameter and had a contour radius of 0.625 in.



The New York Central cars are finished in gray relieved by aluminum striping—The window panel is in a darker tone of gray, outlined with stripes of blue

Lightweight

Pullman Sleeping Cars



The observation room in one of the Pennsylvania observation-lounge cars

Alloy-steel cars of welded construction, 52 of which were recently assigned to the New York Central and 52 to the Pennsylvania, effect a weight reduction of one-third from the previous standard construction

NEW Pullman equipment was placed in service in the Twentieth Century Limited of the New York Central and in the "Blue Ribbon" fleet of four trains* on the Pennsylvania in June, in the construction of which a reduction of weight of about one-third has been effected as compared with the long-established conventional type of riveted construction employing carbon steel. The material of construction is largely Cor-Ten steel and welding has been employed in the fabrication of the car structures to the fullest extent practicable. The cars present smooth exterior surfaces with flush windows, and the roofs are oval in section, without the long familiar clerestory, the function of which has been eliminated by the forced ventilation of air conditioning.

To each of the two railroads were assigned 52 of the new cars. In general construction the cars for both railroads are alike, the differences being largely in certain types of mechanical equipment. The new cars contain an unusual variety of private-room accommodations, from the master-bedroom type, which includes a private shower bath, to the roomette, which provides the privacy of a room in little more space than is occupied by the usual open section. The master bedroom, which has two extra-length folding beds, presents the aspect of a spacious living room, furnished with four chairs, during the day, and has a fully enclosed, completely equipped shower bath room. These rooms are included only in the observation cars and, where they adjoin a double bedroom, can be thrown en suite with the latter by folding back the partition. The other accommodations are the drawing-room, which has been completely rearranged to give the aspect of a comfortable living room during the day, with a luxurious sofa and an upper berth above

* The trains are the Broadway Limited (cars for two complete trains) and the General (New York to Chicago), the Liberty Limited (Washington, D. C., to Chicago) and the Spirit of St. Louis (New York to St. Louis, Mo.), partially equipped.

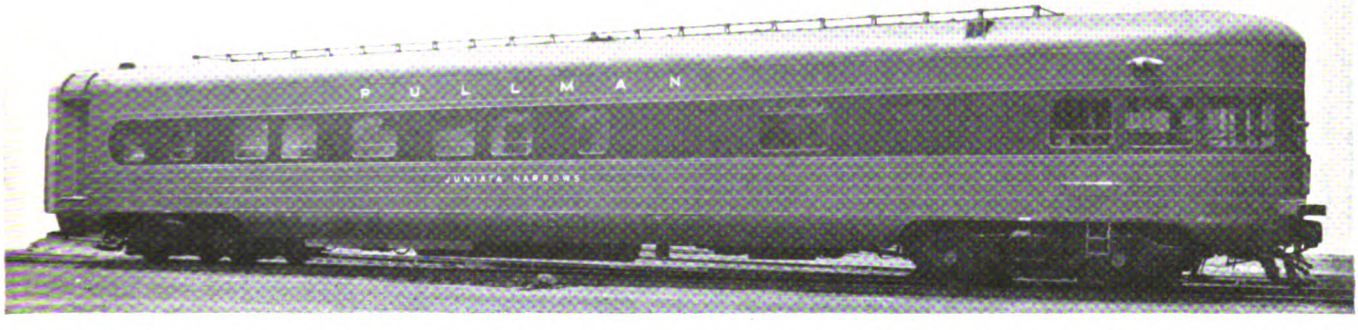
across one end and a third folding bed; a double bedroom, with transverse sofa bed and upper berth; the compartment, with transverse sofa below and a longitudinal upper berth; the upper and lower duplex single rooms with transverse sofa-beds, and the roomette which has a row of completely enclosed single rooms on each side of the aisle, in each of which there is a longitudinal folding bed, a spacious wardrobe, ample luggage storage, and complete toilet facilities. The seat cushions and mattresses are rubber.

Aside from the cars devoted to sleeping accommodations each railroad received barber-shop-bar-lounge and buffet-observation cars of distinctive arrangement for the development of which the roads' own artists were responsible. The New York Central received four dormitory, barber-shop, bar-lounge cars and four combination drawing-room and buffet-observation cars. In each of the former are bunk accommodations in the crew dormitory for 18 persons, a barber shop, a serving bar and a lounge of unusual arrangement. In the latter are a bedroom and master bedroom in addition to the buffet, a general lounge room and an observation room. The Pennsylvania received two bar-lounge cars, each including two bedrooms, a barber shop, and a secretary's room, for use on the Broadway Limited and nine bar-lounge cars, each including one drawing room and three bedrooms, for use on other trains. The four buffet-observation cars for the Pennsylvania each includes two master bedrooms and one bedroom.

The Body Structure

The cars are made of welded high-tensile, low-alloy steel and weigh from less than 115,000 lb. to over 127,000 lb., depending upon the interior arrangement. The lightest units are the bar-lounge and buffet-observation cars, and the heaviest, the roomette cars. The weights of the car bodies, exclusive of water and lading, range from about 76,000 lb. to over 89,000 lb. The weights per car of the trucks range from about 37,500 lb. to slightly over 38,000 lb. The total car weights, exclusive of water and lading, are shown in the table. Alloy steel is utilized throughout for structural parts of the cars and trucks, and aluminum alloys are employed in the construction of the car floors and for the interior trim. Partitions and doors are of aluminum-covered plywood and approximately 500 lb. per car is saved by the use of copper train lines with sweated fittings.

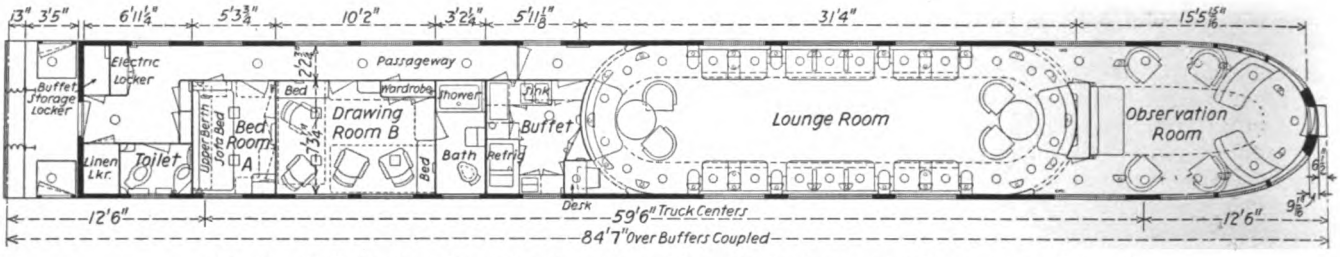
A high degree of riding comfort has been achieved mainly by the use of special spring suspension and roller bearings in trucks. Tight-lock couplers and rubber-cushion draft gears have been employed to eliminate uncontrolled slack between the cars and to minimize



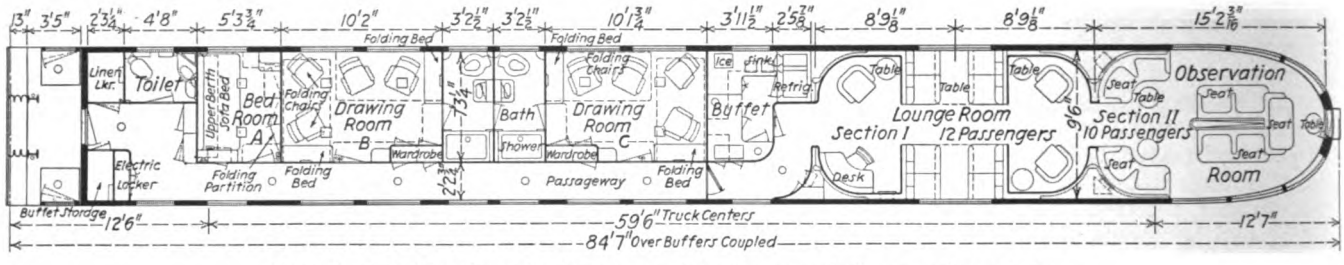
The exteriors of the Pennsylvania cars are in Tuscan red with gold striping and lettering—The window panel is in a darker tone



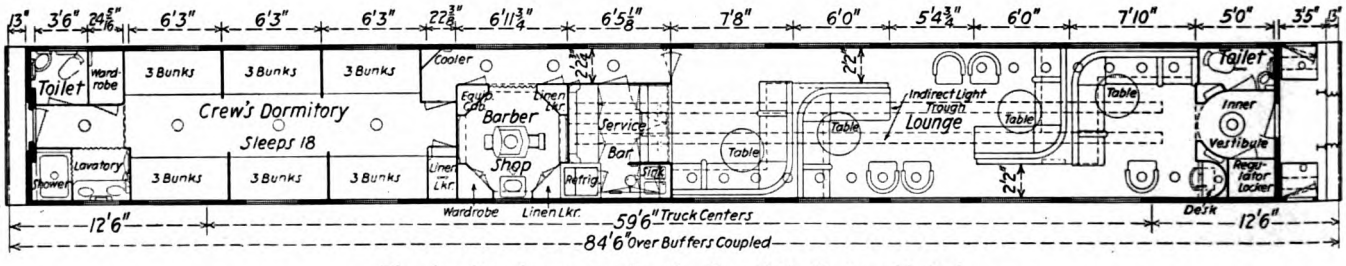
The lounge in the dormitory-lounge car at the head end of the Twentieth Century Limited



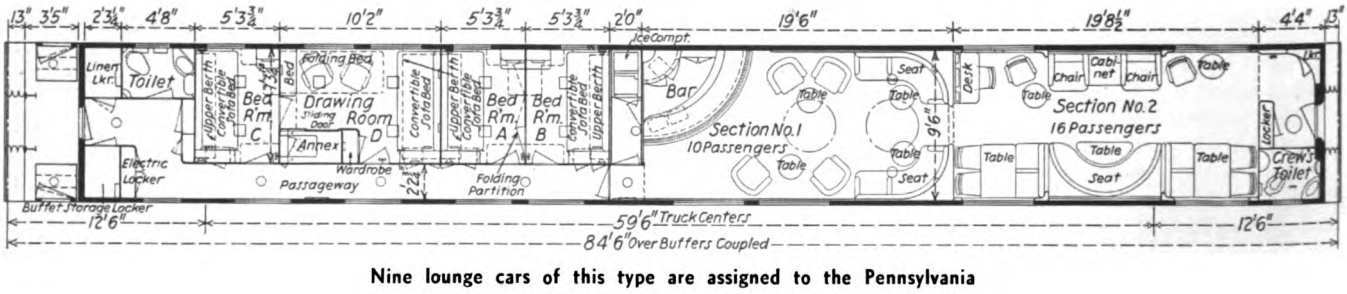
The Twentieth Century observation-lounge car with master bedroom and bedroom arranged en suite



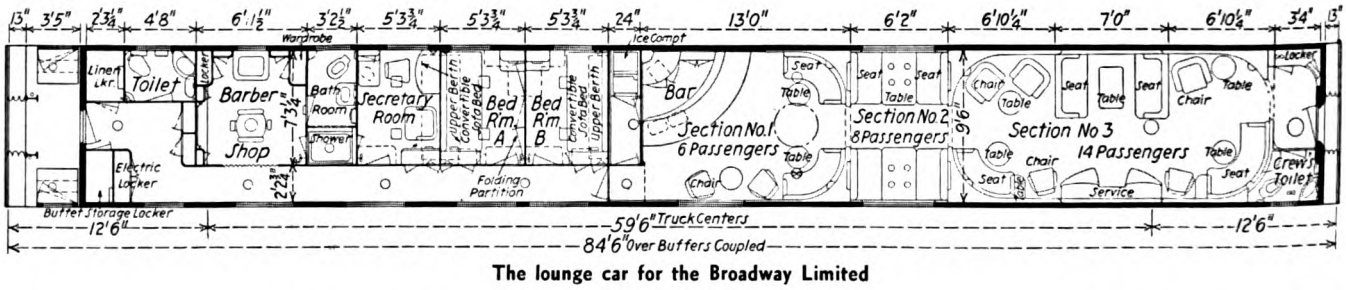
Pennsylvania buffet-observation-lounge car with two master bedrooms and one bedroom



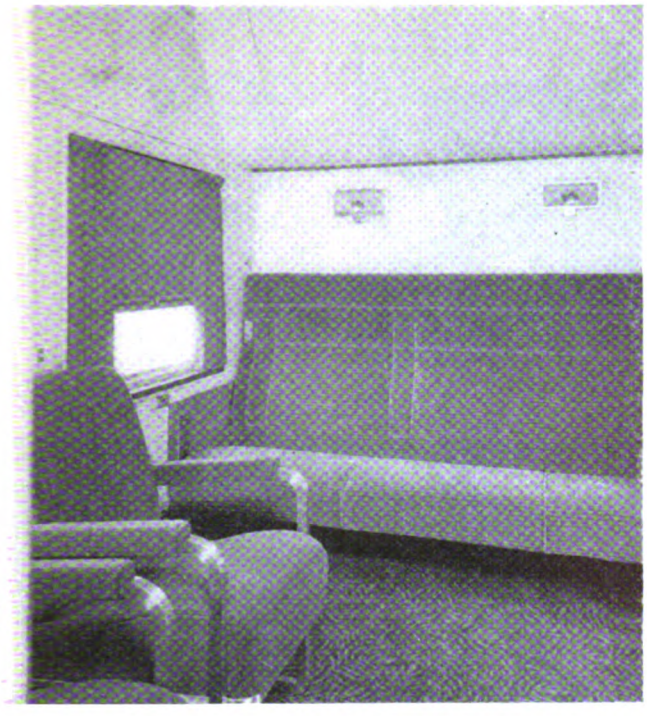
The dormitory-lounge car for the Twentieth Century Limited



Nine lounge cars of this type are assigned to the Pennsylvania



The lounge car for the Broadway Limited



The spacious interior of the new drawing room in the daytime

shocks. Metal-to-metal contact between the moving parts at the ends of the cars has been avoided and train noises largely originating at the wheel and rail contact are transmitted in reduced degree to the car interiors.

The high-tensile alloy-steel body structures are welded together in jigs as far as practicable, employing a minimum of rivets. The exteriors of the car bodies are smooth, both on sides and roof. The sides have inwardly curved skirts, the bottoms of which extend down to within 22 in. of the rail. The side sills are Z-bar section, extending in one piece from the platform end sill to the dummy end sill. Side sills are reinforced to carry the full weight of the car on supports placed between end sills and the bolsters after the car is jacked up. The underframe is designed to resist horizontal compression forces of 400,000 lb. at the center line of buff with a factor of safety of at least two. Corrugated aluminum floor sheets are carried on metal floor stringers with cork filler in the channels and a cork-board floor. The interior side finish and ceiling are $\frac{3}{16}$-in. tempered Presdwood. Partitions and doors are ½-in. Plymetl, double faced with aluminum. End doors are 1-in. Plymetl faced with the same material. The cars are insulated with Stonefelt and Fiberglass. The dehydrated double windows are set flush with the car sides in aluminum frames. All of the windows in the cars assigned to the New York Central are sealed. On the cars assigned to the Pennsylvania most of the windows are sealed, but a few of the inside windows are hinged.

Complete enclosures at each end of the car consist of an inner and outer diaphragm and wide face plate, having a central portion to engage with the face plates of conventional cars, and two hinged side wing portions. The outer cover is of rubber and the inner diaphragm of canvas. Pullman anti-rattling supports, bracing attachments and facing are installed.

National tight-lock couplers have machined ball-joint ends 9 in. in diameter. They are of high-tensile steel, thoroughly annealed. Each group of the Waugh balanced twin-group draft gear consists of six No. 738 Spencer-Moulton rubber mats with separators.

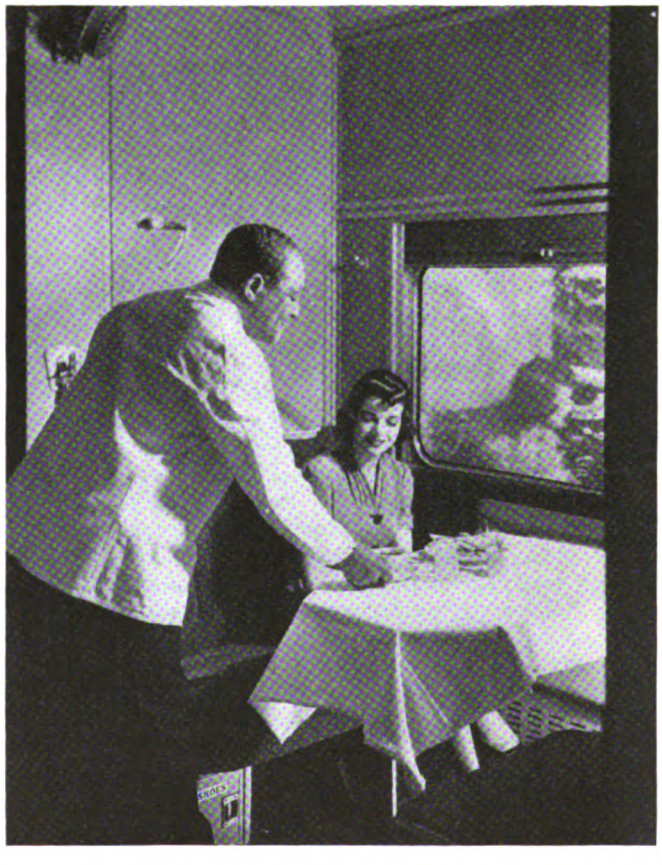
Weights of the New Pullman Cars Assigned to the New York Central and the Pennsylvania

No. cars	Type of accommodations	Weight, lb.*
	"The Century"	
10	17 roomettes; 1 section	125,955
14	2 drawing rooms; 4 compartments; 4 bedrooms	119,021
8	13 bedrooms	121,725
12	5 bedrooms; 10 roomettes	123,492
4	Dormitory; barber shop; bar lounge	114,775
4	1 drawing room; 1 bedroom; buffet-observation	114,350
	The Pennsylvania "Blue Ribbon" Fleet	
13	18 roomettes	127,453
6	2 drawing rooms; 4 compartments; 4 bedrooms	119,851
4	13 bedrooms	123,425
2	Secretary room; barber shop; 2 bedrooms; bar-lounge	118,500
4	2 drawing rooms; 1 bedroom; buffet-observation	116,150
9	5 bedrooms; 12 duplex single rooms	.....
9	3 bedrooms; 1 drawing room; bar-lounge	.....
3	2 drawing rooms; 1 compartment; 1 bedroom; buffet-observation	.....
2	5 bedrooms; 10 roomettes	.....

* Without water or lading.

The Four-Wheel Trucks

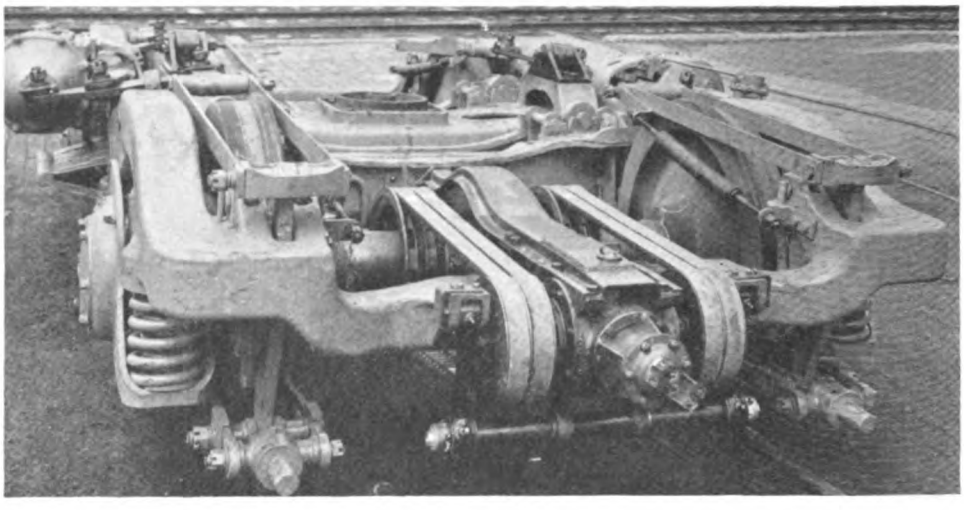
The four-wheel trucks are of the triple-bolster type, without equalizers. The truck frame is supported directly from the wing-type journal boxes through double coil springs. These springs have a compression of long amplitude in the interests of easy riding. Each transom has a double-wall member, within which is a narrow bolster, supported at either end on a pair of coil springs of short travel and relatively high frequency. Each of the coil springs is supported from the transom in a U-hanger. Each bolster, in turn, forms the support for the upper ends of two swing links, one on either side of



A daytime glimpse of a roomette



The Pullman four-wheel triple-bolster truck



Looking at the end of the four-wheel truck showing the air-conditioning drive, the upper ends of the bolster suspension links and brake details

the truck. These links, in turn, support seats on which the main elliptic springs and bolster are carried. The dissimilarity in the frequency of the three springs tends to dampen out harmonic action, and the triple-bolster suspension provides a compound lateral swinging movement of the main bolster and the car body.

The alloy-steel truck castings were furnished by the General Steel Castings Corporation. The wheels and axles, which were furnished by the Carnegie-Illinois Steel Corporation and the Standard Steel Works Company, are fitted with roller bearings in journal boxes of 5½-in. by 10-in. nominal size. The steel wing boxes are designed for coil springs 7½ in. in diameter and are spaced with 36 in. between spring centers. Timken roller bearings are installed in the trucks of the cars assigned to the Pennsylvania, and on 22 of the New York Central cars. The remaining 30 cars assigned to the latter road are fitted with SKF roller bearings. The trucks have Miner roller-type side bearings.

The truck brakes are the Unit cylinder clasp type, with two 12-in. by 10-in. aluminum cylinders and automatic slack adjusters on each truck. The UC brake system installed on the cars gives a 90-per cent service and a 150-per cent emergency braking ratio. Provision is made for the future application of the high-speed features of the H. S. C. schedule. The air-brake equipment on the cars assigned to the Pennsylvania was furnished by the Westinghouse Air Brake Company, and on those assigned to the New York Central, by the New York Air Brake Company.

Heating, Air Conditioning and Lighting

The heating system in all of the cars is the Vapor Car Heating Company's system, with individual thermostatic control of floor heat in each room, except in the roomettes where the heat is manually controlled. The radiator pipes are copper tubing with fin-type radiation. Air conditioning is provided by the Pullman direct mechanical system. On the New York Central the installation does not include the hold-over tank, which, however, may be added at a later date. The hold-over tank is included on the Pennsylvania assigned cars.

Power is supplied for the 32-volt electric system by Safety body-hung generators and lamp regulators of sufficient capacity to handle both the lighting and air-conditioning load. Batteries are Electric Storage Battery Company's low-type mono-block assembly E.I.A.-25, of 877 amp.-hr. capacity. The lamps were furnished by Luminator, Inc., and the Pullman-Standard Car Manufacturing Company. Semi-indirect lighting is employed in the lounge-observation cars, and in the barber shops of the bar-lounge cars is a special soffit lighting arrangement. Edge-lighted glass is used at the card sections of the lounges.

Interior Decorations

In interior color schemes and architectural and decorative treatment, as well as exterior finish, the new cars are unusually attractive. Henry Dreyfuss, industrial designer, was retained as a consultant by the New York Central, and Raymond Loewy, industrial designer, New York, by the Pennsylvania. The unique arrangements of facilities in the club and observation cars thus developed for the two railroads, are indicated on the floor plans.

Combination Lever

Service Failures

By Fred H. Williams, M. Sc. F. R. S. A.

FAILURES of combination levers in the link motion of steam locomotives have not been unknown in the past. Improvements have, of course, been made to overcome the weaknesses, but occasional failures still occur, a consideration of some of which may be profitable. These levers are made in a great variety of designs, some of which are shown in Fig. 1. These are not necessarily intended to be typical, but in a general way they indicate the characteristics of such levers.

Sometimes the best way to drive home a truth is to illustrate a rather exaggerated case. For this reason

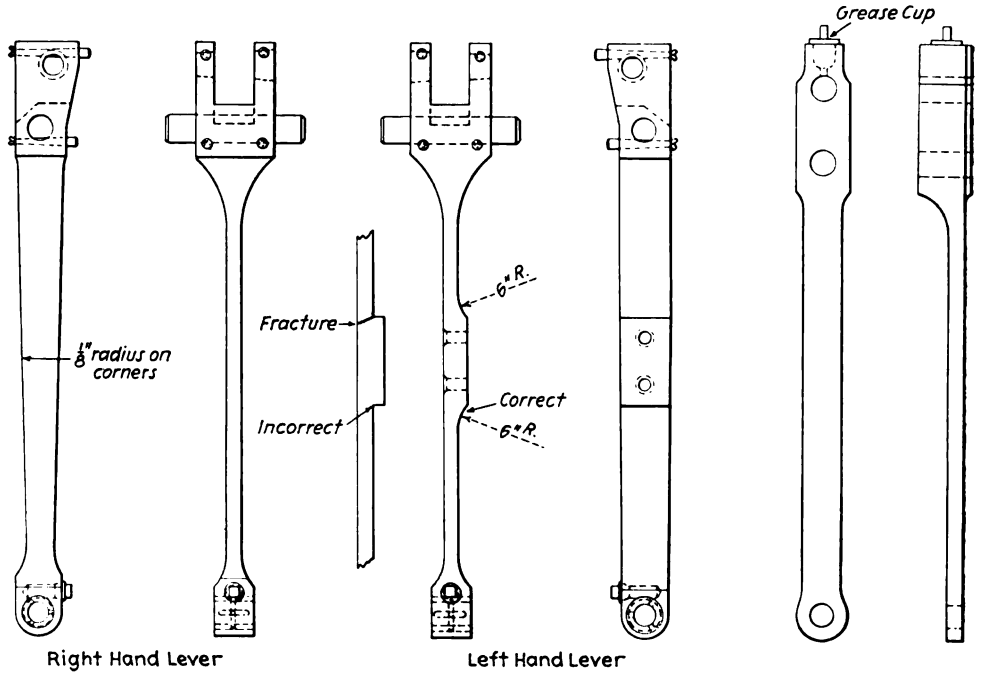


Fig. 1—Various designs of combination levers

I have selected the broken combination lever illustrated by Figs. 2, 3 and 4. This lever had several defects in its finish and it is quite apparent that it had been repaired, one might almost say, in the backwoods, so crudely had the work been done. The face, that has been built up by welding, looks like a mangy cat.

A side view of the lever is shown in Fig. 2. The portion that was poorly built up by welding, bad as it is, may be left out of consideration, for unfortunately there was a still weaker spot which caused the failure. This was the stamping of the letters and figures on the side of the lever. This might not have proved so disastrous had the stamping been lengthwise, but placing it crosswise weakened the section so greatly that the part failed even before a fatigue crack could get started. Aside from the cause of the failure, a critical examination of the lower hole also shows that it was worn more at the top than at the bottom, indicating that there was a greater bearing pressure at the top. It would appear that the lever gradually pulled apart, much like a test piece, the steel stretching before failure. Another theory might be that because of the rough finish on the face a binding resulted, placing undue pressure on the lever and causing it to give way at the section which was weakened by the stamping.

The opposite side of this lever is shown in Fig. 3. It will be noted that the surface connecting the body of the lever to the forked end was milled quite roughly. This is bad practice.

Another view of this same combination lever is shown in Fig. 4. The finish here is somewhat better than in Fig. 3, although obviously a smoother finish is not so necessary on the thicker parts, which are subjected to less stress than the thinner section of the lever where the fracture took place. A sketch which will give a clearer idea of the design of the end of the lever is shown in Fig. 5. Since the finish between *X* and *O* is comparatively smooth, it is quite possible that the section from *X* to *X*, which is quite rough, may have been a later machining, indicating a possible reduction from the standard dimension of the section at the fracture.

A failure of another combination lever that resulted from a fatigue crack is shown in Figs. 6 and 7. It will be noted from Fig. 6 that the finish was quite smooth to within a short distance of the fracture, when the good work stopped, and not only is the surface much rougher, but there are tool marks crosswise. The fracture started at the right in the deeper part of this crack. Matters were made worse by the fact that the lever had a boss on it similar to the one shown on the sketch in Fig. 1 and in Fig. 8. There seems no reason why a generous fillet could not be provided, but the corner was cut square.

The fatigue crack started in the tool mark and progressed through two-thirds of the section before final fracture. This would seem to indicate that the part

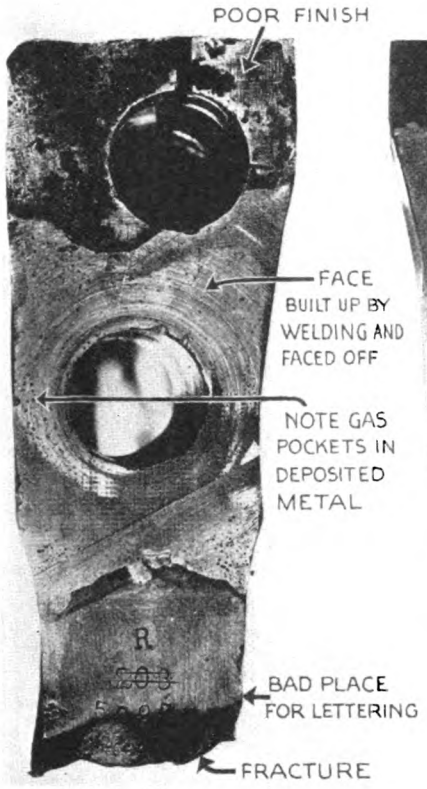


FIG. 2

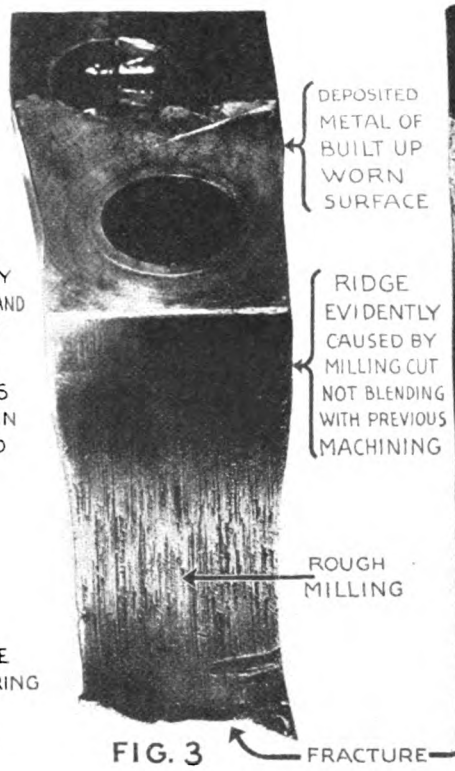


FIG. 3

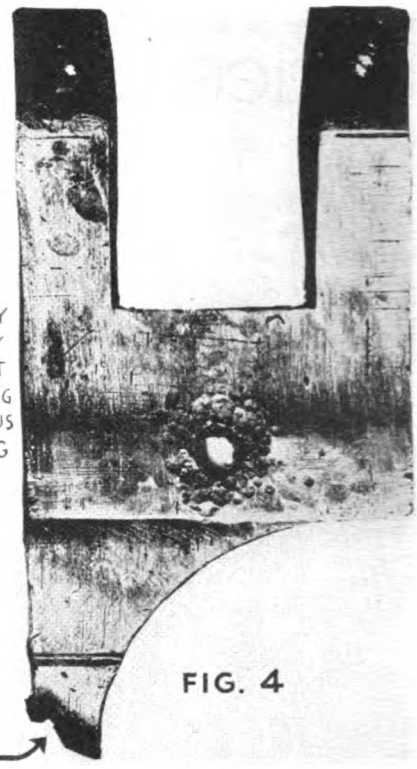


FIG. 4

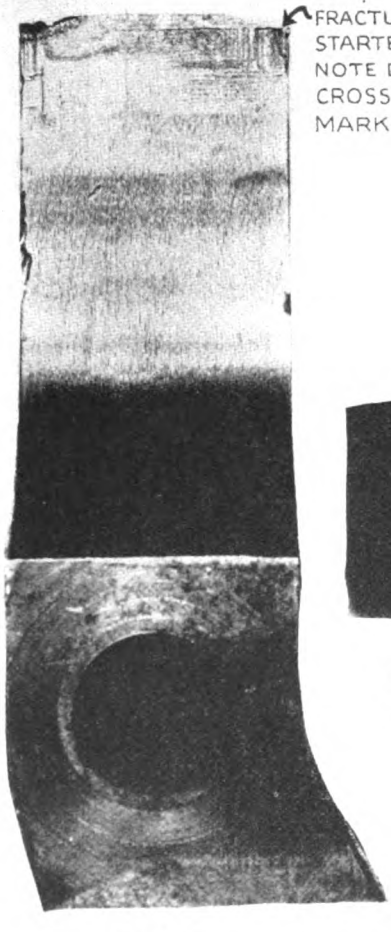


FIG. 6

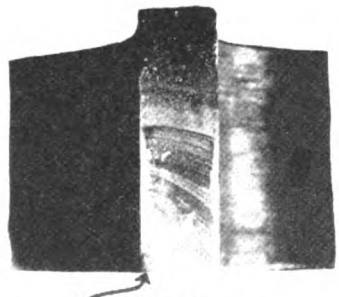


FIG. 7

NUCLEUS OF FATIGUE CRACK (SEE FIG. 6)

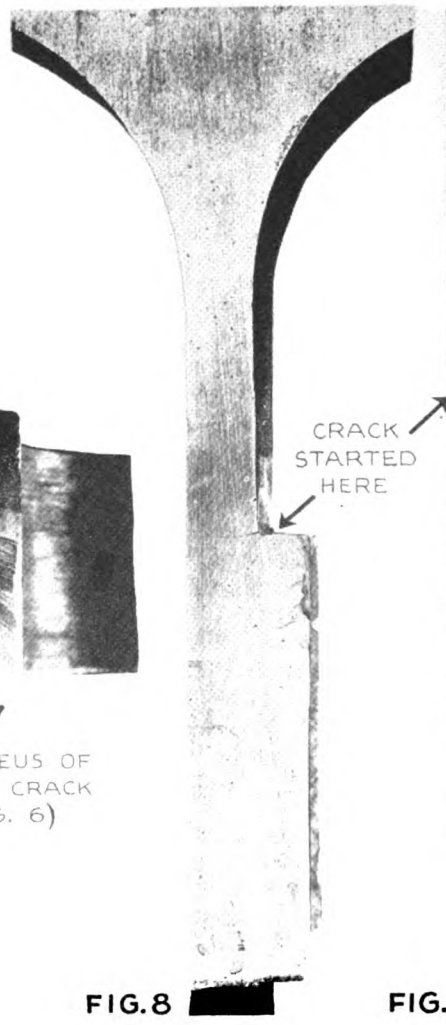


FIG. 8

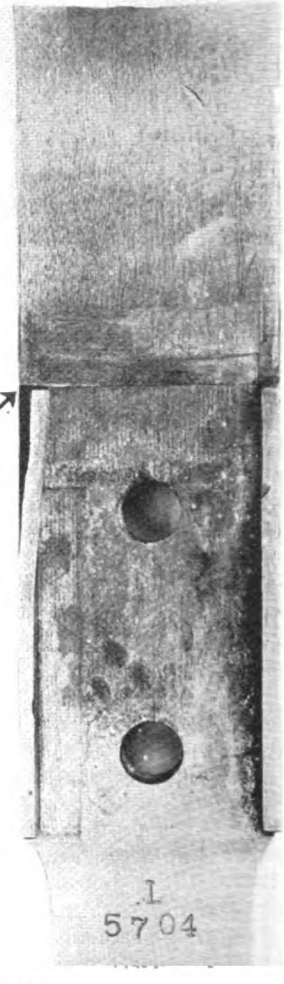


FIG. 9

Fig. 2—Side view of a portion of a combination lever which failed in service; fracture at lower end. Figs. 3 and 4—Other views of fractured combination lever shown in Fig. 2. Fig. 6—Side view of a combination lever that failed because of tool marks. Fig. 7—Face of fracture on combination lever shown in Fig. 6. Figs. 8 and 9—Illustrating how crack started on combination lever of same design as that shown in Figs. 6 and 7

was operating properly and that with a good finish the crack would not have started and the failure would not have occurred. Fig. 7 shows the face of this fracture.

An instance of this sort may cause friction between the designer and the shop man. The latter will insist that the drawing should be complete and quite definitely indicate the proper radii for the fillets or for rounding the corners. The designer, however, may argue that the shopman should take care of such details without having

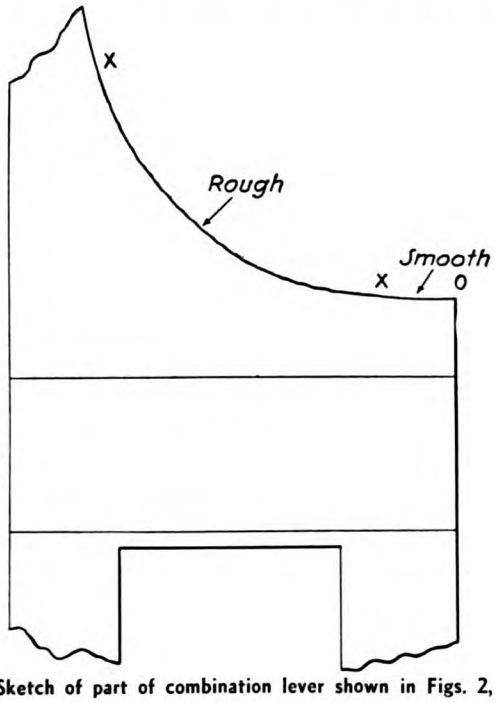


Fig. 5—Sketch of part of combination lever shown in Figs. 2, 3 and 4

them specifically brought to his attention on the drawings. Unless there is a very clear understanding as to the standards of shop practice in this respect, the drawing room should in all cases see that these details are thoroughly covered and specified. This is now the standard practice on our railway.

In order to make the preceding failure of the combination lever more clear, Figs. 8 and 9 are presented. These show views of a similarly designed lever which did not actually fail, but which was taken out of service because of being defective. It will be noted that there is a small crack where the section changes in Fig. 8. This weak spot could easily have been eliminated. Instead of machining the lever crosswise and making a sharp change in section, a generous fillet could have been provided in the milling operation. Formal lines are all right in a garden, but are strangely out of place in the design of such a part, if long life is desired. In a side view of this same combination lever, Fig. 9, the cross tool marks are clearly shown and even the crack which had started is more or less visible. A good finish right down to the crucial spot, and then uncouth tool marks and a square corner present a pitiful picture of sloppy workmanship. Even a good design may be ruined by crosswise tool marks. Too great a factor of safety will be required to offset rough finish and tool marks.

Soo Line 4-8-4 Type Locomotives

(Continued from page 364)

lubricated through the Alemite soft-grease fittings. Westinghouse mechanical lubricators are applied to the air compressors.

The cab windows have double glass for clear vision. The windshields are shatterproof glass. Cab heat is provided by steam radiators. Cut-off control is guided by a back-pressure gage. Superheated steam is supplied to the air pumps and blower lines.

The locomotives are equipped with Westinghouse No. 8ET brakes with two 8½-in. cross-compound compressors. These are placed on the front end of the bed casting.

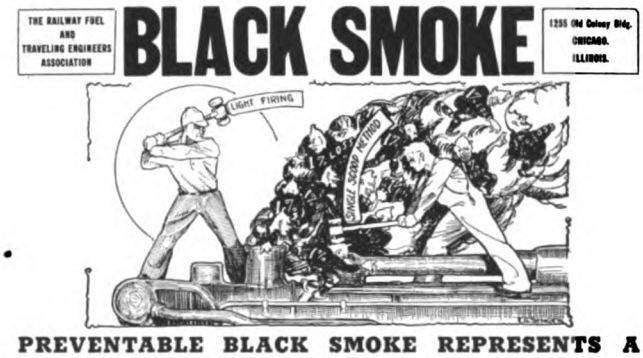
The Tender

The tenders are built-up on General Steel Castings water-bottom underframes with open-hearth copper-bearing steel plates. They are fabricated largely by welding.

The tender trucks are the Buckeye six-wheel type with 33-in. Multi-Wear rolled-steel wheels and bronze journal bearings. They are fitted with A. S. F. clasp brake rigging with a body-mounted brake cylinder.

The engine and tender connections consist of the Unit Safety drawbar, the Franklin type E2 radial buffer, and Barco flexible connections for steam and air. The Miner A78-XB draft gear is applied at the rear of the tender.

* * *



PREVENTABLE BLACK SMOKE REPRESENTS A LOSS OF AT LEAST 10 PER CENT.

THE FOLLOWING PRACTICES WILL HOLD THE ESCAPING CARBON UNTIL IT CAN BE COMPLETELY BURNED

1.—SINGLE SCOOP METHOD OF FIRING. ON STOKER FIRED ENGINES RUN THE STOKER AT A UNIFORM MINIMUM SPEED.
2.—ALLOW FIRST SCOOP OF COAL TO IGNITE BEFORE ANOTHER IS PUT INTO FIREBOX.
3.—MAINTAIN LIGHT LEVEL FIRE. STARVE THE FIRE AS MUCH AS POSSIBLE UNDER ALL CONDITIONS.
4.—KEEP FIREBOX TEMPERATURE HIGH.
5.—PLAN FIRE CONDITIONS MANY MILES BEFORE ARRIVING AT STATION AND AVOID PUTTING COAL INTO FIREBOX AT STATION.
6.—PLAN WATER LEVEL. GOOD PUMPING IS A MAJOR FACTOR IN GOOD FIRING.
7.—DO NOT ALLOW A BANK TO ACCUMULATE IN ANY PART OF THE FIREBOX. A BANK REDUCES GRATE AREA, INCREASES RATE OF COMBUSTION, AND REQUIRES FORCING THE FIRE.
8.—ENGINES LEAVING TERMINALS SHOULD HAVE FIRES IN PROPER CONDITION TO DO EXPECTED WORK.
9.—ADD JUST ENOUGH COAL TO ABSORB AVAILABLE OXYGEN (AIR). THERE IS A DEFINITE RATIO BETWEEN OXYGEN AND COAL—WHEN MORE COAL IS ADDED MORE AIR IS REQUIRED TO COMBINE WITH IT IN ORDER TO MAINTAIN SMOKELESS COMBUSTION.
10.—KEEP FIREMAN POSTED AS TO POSSIBLE SHUT-OFFS.
11.—KEEP FLUES CLEAN AND FRONT ENDS TIGHT.
12.—KEEP POWER REVERSE FROM CREEPING.
13.—KEEP VALVE AND CYLINDER PACKING TIGHT.
14.—MAINTAIN GRATE RIGGING SO THAT GRATES OPERATE FREELY, BUT ARE WELL FITTED AND WITHOUT HOLES.
15.—KEEP VALVES SQUARE.
16.—AVOID STOPPING TRAINS UNNECESSARILY.

Fuel bulletin recently issued by the Railway Fuel & Traveling Engineers' Association

EDITORIALS

Mechanical Associations Hold Active Meetings

The Car Department Officers' Association, The Railway Fuel and Traveling Engineers' Association, and the Master Boiler Makers' Association are convening at the Hotel Sherman in Chicago on September 27 and 28 for a full program of papers and committee reports, while the officers and executive committee members of the International Railway General Foremen's Association are meeting to plan the program for a convention next year. The determination of these associations to meet this year is evidence of the seriousness with which they view their part in helping to solve the difficulties which seem to be closing around the railroads from every direction. For while the need to curtail expenses at every point creates pressure from many sources to cancel meetings, the officers and members of these organizations of mechanical-department supervisors know that it is at just such times as these that their meetings may have the greatest value to the railroads.

More so than ever do these associations need the encouragement of railway executive officers, encouragement free from official domination or censorship to proceed with ways and means to improve the effectiveness of their work. When one listens to the papers and reports with the earnest discussion which follows from the men directly responsible for the actual performance of motive power and rolling stock, he must be convinced of their devotion to their work and the sincerity of their purpose to improve themselves and to help others through the exchange of information relative to their work, the benefits of which accrue to the advantage of the railroads they serve. No railway officer or organization need have concern regarding the attitude of the mechanical associations toward their work; these associations know their problems and strive to solve them without conflicting with the problems or programs of others. A complete understanding of these facts by executive officers will do much to allay the concern which the supervisors' associations have felt existed on the part of railway executive officers and other organizations regarding their present and future activities.

At least some of the expense of holding the mechanical association conventions is met by the railroads, and in these trying days when the saving of money is the dominant cry, many officers are averse to sending their supervisors to meetings from which no immediate returns can be computed in dollars and cents. However, whatever expense is incurred, it is a cheap price to pay for the educational results secured, the suggestions supervisors receive for new ways of exercising ingenuity and the inspiration which sends them back to the job with renewed courage and determination to surmount the never-ending obstacles with which they are confronted. The support of executive officers who possess the insight to trace improvements in the functioning of their organizations to the successful operation of these associations is sorely needed to combat the many obstacles placed before those responsible for their continued existence. Not the least of these obstacles is the inability of some executives to sense the worth of intangibles, which are often of incalculable value in the success of an operating organization.

Savings Made in Modern Flue Shops

Today in many shops is to be found much antiquated equipment for the handling, cleaning, safe-ending and cutting of flues which increases the time for repairs and holds shop maintenance costs at a high level. Much of such equipment undoubtedly performs satisfactory work and is continued in service for this reason or because of the lack of money to purchase new equipment. With modern flue-shop equipment, flues and tubes are moved from one machine to another rapidly and efficiently with a minimum of manual handling. For example, there are available tables or racks on which several sets of flues can be loaded and rolled through the length of the flue shop from one machine to another. High-speed friction saws for cutting off flues and tubes can be supplied and located near such a table. Also, adjacent to the flue table or racks can be placed power-driven rolls for pulling flues and tubes through scale-cracking machines at rates of 14 ft. per min. for a 5½-in. tube to 22 ft. per min. for a 2-in. tube. After this operation, the flues can be replaced on the tables and moved to the electric resistance welder where safe ends are applied. A recent innovation on the resistance welder is an air blast which blows slag from the tube interior during the flash period, thus preventing the formation or a ridge on the inside which is the obstacle to the insertion of superheater units.

A shop laid out with such modern equipment can effectively handle between 8,000 and 12,000 flues per month with a minimum of men. When one visits a flue shop where he sees modern equipment of the type mentioned in use and then visits another shop where older types of flue repairing equipment are installed, he wonders why the latter shop does not take advantage of modern developments to reduce flue repair costs. In some cases savings can be made by retiring pneumatic

swedges in favor of electric resistance welders. Layouts of shops can be changed to reduce handling of flues and tubes and expedite their movement through the shop.

Most flue shops are laid out to obtain progressive movement forward of the flues from the time they are removed from the boiler until they are ready for installation. Not all shops, however, effect such movement to the best advantage because of the peculiarities of older types of flue-repairing equipment. Undoubtedly, the installation of modern equipment entails, in some instances, a new shop layout and probably slightly enlarged floor area. This may or may not be the case, depending upon local conditions and existing premises. Whatever changes are necessitated in shop layout for the installation of modern equipment would, however, be justified by the reduction of flue-repair costs unless the load factor is too small to utilize a reasonable part of the capacity of the new equipment.

Increase the Efficiency Of Material Handling

When a process or appliance becomes absolutely essential to the successful operation of a shop, one often finds it being used indiscriminately to the detriment of shop efficiency. Not infrequently do we find such a situation existing in regard to mobile material-handling equipment, such as power trucks, cranes and tractors. In the use of such equipment, great savings can be made by avoiding duplicate handlings. In this respect, pallet- and fork-type hand and power trucks, motorcycles, light automobiles, and special trailers and skids have great possibilities for moving material and parts both ways in intershop, interstation and line shipments.

A check made recently on one railroad showed that, by careful ordering, by careful shipping, and by providing proper equipment, handling can be reduced from about 15 per cent to approximately 7 per cent, while the speed of handling can be increased from 3 to 6 m. p. h. Where material is to be shipped to one point and reshipped to another point within a short period, material should not be removed from skids or platforms but rather storage space should be provided in storehouses and yards for material on skids or trailers in transit. Such practice will avoid much rehandling expense.

The efficiency of material handling can be improved by increasing the speed of handling, especially by increasing the speed of mobile units. The trend in the design of trucks, cranes and tractors is not only towards increased travel speeds, but also towards increased hoisting, lowering and slewing speeds where these are functions of the equipment in question.

Roadways are essential to the economical and speedy handling of material. Well-designed concrete roadways in yards, shops and enginehouses, as well as those interconnecting these places and the storehouses, play an effective part in reducing handling expense. Not to be overlooked in this respect are clear areaways in the shops, yards and storehouses.

The last report on material handling by the Purchases and Stores Division of the A. A. R. pointed out that efficiency of material handling can be increased by ordering material in carload lots, by moving carloads directly to the points where they are needed, by the use of open equipment, by the use of separators or bundles to assist in unloading at destination, and by the use of standard packages. Thought should be given, when preparing purchase orders, to the necessary rehandling required when redistributing material to other points on the railroad, and making such orders in a way that will require a minimum of handling of small shipments through main storehouses and freight houses. In this respect, auto trucks and motorcycles can be used advantageously in interplant and interstation movements for small lots of materials, thus saving switching and delays.

In intershop shipping of material, one finds the greatest savings made where definite schedules of material-handling equipment are maintained. If orders are placed in storehouses for handling at definite times, equipment for handling the orders can be used to capacity, rather than used inefficiently by making a number of miscellaneous trips from storehouses to points of use. Some of this miscellaneous handling cannot be avoided, of course, but many shops have found that it can be reduced materially when careful study is made of the material-handling problem.

What Will Be Gained?

On this page a month ago a question was raised as to whether wage rates alone were the issue in the present wage controversy between the railway managements, on the one hand, and the Railway Labor Executives' Association and the Brotherhood of Railway Trainmen, on the other. It was suggested that actions of the labor executives throughout the various stages of the negotiations following the proposal of the railroads to reduce wages have better served the purpose of the European left-wing philosophy, which preaches the class struggle and the destruction of private ownership of all instrumentalities of production, than of the salvation of railway transportation under private ownership. A recent development adds weight to the suspicion that the objectives of the labor executives have not been fully stated.

On September 20 President Roosevelt appointed a committee of three labor-union representatives and three railway executives who were asked to study and offer recommendations for a solution of the general railroad problem, of which the wage-reduction proposal of the

railroad is regarded by the President as but one aspect. The committee was expected to report within about a month. Following its meeting on September 21 a statement issued on behalf of the committee indicated that "the time of the labor executives will be so fully occupied during most of October" that the next meeting of the committee had been postponed to a date later to be fixed. Thus, the labor executives have maintained their attitude, already evident, of "After us the deluge," so far as the general welfare of the industry which supports them is concerned.

If this continued course of non-cooperation ultimately succeeds in preventing a solution of the railroad problem under private ownership, thus forcing management and operation into some form of political control, no doubt the next step will be political pressure to dominate the management of the railroads for the benefit of the labor organizations at the expense of the public. It may, furthermore, be inferred that the brotherhoods who occupy a strategic position because of their immediate connection with the movement of trains will be no more sensitive to the interests of maintenance and other employees more remotely connected with the movement of trains than they have been in the past. Some of the brotherhood officers are still talking in defense of hours paid for but not worked, which account for more than one-sixth of the total compensation of the train-service employees as a whole, for more than one-third in the case of road passenger conductors, and for nearly one-third in the case of road passenger enginemen, which they get at the expense of employees in other departments.

All railway employees should give careful weight to the fact that the railways no longer have a monopoly on transportation; that any apparently successful attempt to hold up the public again, such, for instance, as that of the brotherhoods in the fall of 1916, will result in the drying up of traffic and the ultimate disappearance of jobs. Further victories at the expense of the public will prove worse than empty.

Safety and Good Tools

The relation of good tools to safe operation in railway shops and engine terminals is well known but may sometimes be overlooked. It is, accordingly, a pleasure to note the emphasis given this subject in an address delivered at the September 12 meeting of the Car Foremen's Association of Chicago, by P. F. Buckle, superintendent of safety, Chicago, Burlington & Quincy. Quoting directly, Mr. Buckle said, "This enthusiasm has led you to create more and more labor-saving devices which are ingenious in the results they obtain, and whenever you lighten the labor of a worker you lessen hazard exposure."

In discussion following the address, M. E. Fitzgerald, past president of the association, and master car builder of the Chicago & Eastern Illinois, made the same point, namely, that one of the most effective means of reducing accidents is by the use of labor-saving devices such as power-operated jacks, saws, hammers, clamps and special tools of all sorts, which save manual labor. This avoids over-tiring men and, as a result, they are more likely to be alert, and quick and always ready to avoid danger under any circumstances which may arise.

Obviously all tools, whether hand or power-operated must be kept in good working condition or innumerable potential hazards will exist. Properly dressed chisels, sound hammer handles, well-guarded circular saws and other tools do much to improve safety records in any man's shop. One word of caution may perhaps not be amiss as regards the many air-cylinder operated devices which are so popular as to be found in almost every shop and designed for performing almost every conceivable kind of an operation. For pressing and forming work, the resistance to movement of the air piston may build up to a certain point and then give way, causing the piston to jump forward unexpectedly and catch an unwary hand in the mechanism. Then again, total pressures of great magnitude may be developed in large air cylinders and "rule of thumb" shop men, without a full appreciation of the pressures involved, are likely to build a device with some undersize part which will fail in service and possibly cause an accident.

Suitable guards for these air-cylinder operated devices are also especially essential, as for example, in the case of the very neat and efficient pipe vise installed in one shop and used for some time before it was discovered that the downward-operating piston push rod came within ¾ in. of the floor at the end of the bench where some unoffending foot or toe was almost sure to get in the way in due course of time. The installation of a simple sheet-metal guard at this point unquestionably prevented a painful accident.

Eternal vigilance is the price of satisfactory records in all branches of safety work and nowhere is this more true than as relates to the provision of an adequate supply of labor-saving tools which are always kept in condition for safe and efficient use.

New Books

FAILURES OF LOCOMOTIVE PARTS. *By Fred H. Williams, M.Sc., F. R. S. A., 71 Cornwall avenue, Town of Mount Royal, P. Q., Canada. 35 pages. Price, imitation leather binding, $5; paper cover, $4, plus duty.*

Mr. Williams has reprinted in loose-leaf binder form his series of articles on the Failures of Locomotive Parts and How to Prevent Them which were run in issues of the *Railway Mechanical Engineer* from May, 1936, to March, 1937. The series deals primarily with failures of side and main rods, tires, wheels and axles.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Piece-Work and Apprentice Training

While I have little against piece-work in general, I feel that it is one of the major factors in poor apprentice training. Most mechanics think only of the coming pay check, and thus tell the apprentice what to do to expedite the job in hand, rather than why the job is done in a certain way and giving the apprentice the complete story of the job. Many apprentices encourage this attitude, since regular apprentices share in the piece-work earnings. Graduates from this type of apprentice course are very poorly fitted to do a high-class job on any equipment, much less that being built today.

Blinders on Shop Supervisors

The supervision on a railroad for the most part have to work such hours that they lose contact with what is actually going on in the world at large. It is natural; men in the shops work six full days a week and never see even the town in which they live, save at night. Seldom are they ever sent out on inspection trips. If any such traveling is done, it is by men from the office, who are not intimately acquainted with the subject upon which they are working, often not even with the fundamentals; and after all, we have the fundamentals, it is the fine points that need research. The attitude that the shop men aren't qualified for such seems to come from a superiority complex, that of the white collar man against the man who works, and enjoys it. The result is that your average supervision under suppression assumes the attitude: "The print calls for it, I'll only be reprimanded if I do this as logic would dictate." Not those words, you can bet, but to that effect. And no average man likes to do bad work, but when forced to, does, and hates to do it. I've seen it over and over again. This comes from lack of co-ordination and misunderstanding.

Pertinent Questions

Is there any association related to the railroad mechanical department that studies and reports on problems of dealing with the human element in the shop and enginehouses? As a foreman I am coming to the conclusion that that is the most important part of my job, and yet I have never had any particular coaching as to the best ways of dealing with the workers under me. Would it be worth while to try to attend a foreman's club in an industrial town near here? It will be difficult for me to make the trip, but I imagine we may have much in common, particularly since I notice that many of their programs are concerned with human relations problems.

Why Worry?

One often runs into the attitude of "What do you care as long as they keep on paying you?" The best answer that I know to that is that for most of us railroading has a real fascination and we intend to stay in it as long as we can. Present training policies, or rather, the lack of them, are harming our future capacity and earning power and perhaps damaging the railroads themselves. I realize, of course, that the really ambitious and energetic young man will usually get ahead in spite of things, but perhaps it is because I am not so ambitious or energetic that I am blowing off steam tonight! The average fellow ought to have a better chance, for the benefit of all concerned.

Special Apprentices in Overalls

I also believe that specials should be given greater opportunity to get into overalls and do some of the actual work. In addition to getting some very valuable practical experience, one gets a very good insight into the problems and methods of thinking of the average workman. The usual college man is apt to be rather "superior" and above menial labor, but such experience is a very real help to a conscientious man. If one is going to be in charge of a group of men, he must be able to understand them and hold their respect—and know a lot about their jobs also. I feel very grateful for such experience as I have had along this line.

Photo by Edward Bolsetzian



Boston & Albany No. 576 pulling the Ohio State Limited at about 65 m.p.h. past Oak Street Station. Engine 1053 of the way freight is in the hole. S. S. Pan film 1/100 second, F 6.3

IN THE BACK SHOP AND ENGINEHOUSE

The Welder's Viewpoint On Coated Rods

*By A. L. Havens**

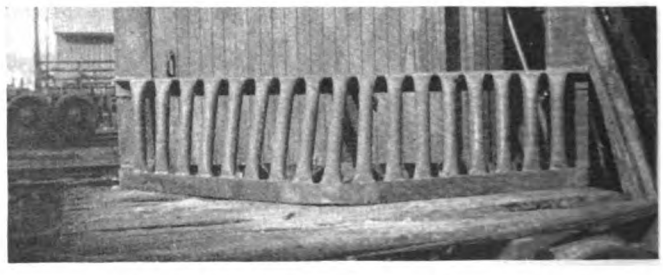
It is an accepted fact that the innovation of shielded-arc electrodes, or coated rods as they are more commonly called, has brought arc welding to the front by leaps and bounds, and while bare rods still have a place in railroad welding they fall far short where strength is imperative. Also, a weld made with coated-rod will machine as free from imperfections as the parent metal. It is needless to compare at length these two types of welding rods, since it is known generally that coated-rod welds, when properly made, are from 20,000 to 40,000 lb. per sq. in. stronger than the same weld made with bare rod.

This in itself should be enough to convince anyone on the advisability of using coated rods. However, speed must also be considered. For example, consider the accepted practice in a certain railroad shop were lateral wear on crosshead guides was built up with $\frac{3}{16}$-in. bare rod. The average time on one of these guides, generally worn about $\frac{3}{8}$ in., was 20 hr. After experimenting with several different sizes of coated rod, it was found that by using $\frac{5}{16}$-in. rod these same guides could be built up in about 6 hr., a neat saving in both time and money. Since using coated rods, complaints are no longer heard from machine operators who plane the guides.

A good example of the popularity of coated electrodes is found in the increased amount of this type of rod used on a small New England railroad. In 1934, this road purchased 150 lb. of coated rods while in 1937 they used nearly 4,000 lb. One reason for the increased use of this rod is due, no doubt, to the fabrication of several locomotive parts that were previously purchased as castings. Petticoat pipes, pilot-braces, smoke stacks and many other locomotive parts are now cut out in the boiler shop and welded.

It is often necessary for the railroad welder to prepare and weld fractured parts under tremendous strain in places or positions which make it practically impossible to secure the necessary expansion. This is another spot where coated rod comes to the rescue. Broken driving-wheel hubs and locomotive frames are probably the most important. Perhaps these repair jobs aren't always successful, but sometimes it is imperative to keep a locomotive in service for a few weeks, especially on a small road. There is no excuse for failures with coated rod on frames if the operator will observe certain rules and regulations. He should be sure all slag and oxide are removed from the scarf by chipping the vee bright, and as the welding progresses the slag should be removed from each successive layer. If it has been impossible to secure any expansion, caution should be exercised to avoid over-heating; it is better to take a little longer and have a successful weld than to rush through it and have it break. After completing the weld, it is a good plan to reheat or stress-relieve the area welded; this is generally done by building a small fire-brick or block-asbestos furnace around the weld and heating to a dull red with a blow-torch.

Broken driving-wheel hubs present a different problem. The best procedure is to remove the wheel from the axle, but sometimes time limitations make it necessary to cut out the break and complete the weld without removing the wheel. Without coated rods this latter method would be out of the question, since a bare-rod weld would most certainly break. A weld such as this was completed by the author, which has been in continuous service for 30 months. This repair was made in the enginehouse without removing any parts whatsoever and the locomotive never missed a trip. The welder who had this job started burning it out at 3 p. m., cutting as much of the crack away as he dared. Afterwards he chipped the vee bright with an air hammer and started the weld, which was completed at 9 p. m., using 41 lb. of $\frac{5}{32}$-in. and $\frac{3}{16}$-in. coated rod.



Welded pilot made from scrap boiler flues and angle iron

Many cast-steel frame braces and brake-post brackets seem to have a faculty of cracking and breaking. Although the welding of these parts was once a more or less everyday job for the enginehouse welder, they are now welded once and that is all. Sometimes it is necessary to cut away large portions that have been previously welded by other methods, and where this is done the metal that is cut away is replaced with pieces of boiler-plate and the whole assembly welded with coated rod.

It is impossible to place too much stress on the fabrication of locomotive parts by welding with the shielded arc. One of these, of no little importance, is the pilot. In our shop these are made entirely by the welders from scrap boiler flues and angle iron, these pilots are made to standard specifications and are interchangeable on all locomotives. They are very simple to make; one welder working alone will complete two in 20 hr.

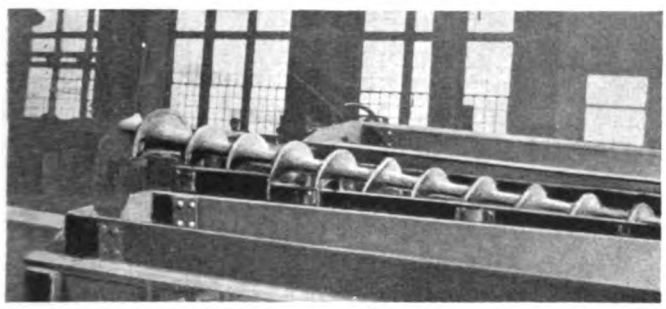
Another item of importance is the smoke stack and the smoke-stack extension. One railroad at least now makes these two parts entirely of boiler plate. This creates a considerable saving and makes another job for the welders. It has been an accepted fact that the cast-iron parts would wear much longer than steel for stacks and extensions; however, the author has found this not to be exactly true for the steel parts have been found to wear equally well.

Everyone is probably familiar with the practice of building up worn locomotive and car knuckles, which

* Lead Welder, Rutland, Rutland, Vt.

has always been a more or less rainy-day job in the railroad shop. Some knuckles lack ½ in. of being up to gage while others require only ¼-in. deposit of metal. Some roads make a practice of applying small plates of the proper thickness to these worn spots but this has not always proved satisfactory, as the plates soon fall off and leave the knuckle as bad as ever. Different methods of rebuilding these knuckles have been tried in our shop, all of them being fairly successful. As cost is the primary factor in this application, the management has always worked toward lowering the expense of welding knuckles, and, with the introduction of coated rod on this job, a substantial saving has been made, the cost of welding each one being but a few cents each.

Rebuilding stoker elevator and conveyor screws makes an ideal application for shielded-arc welding. These parts when new are expensive, so while it takes quite some time to rebuild one back to standard size there is still a saving of nearly 50 per cent of the purchase price. As a rule, the flight of the screw is all that is worn on the elevator; the diameter is generally worn at least ¾



Stoker conveyor screw reclaimed by welding with coated rods

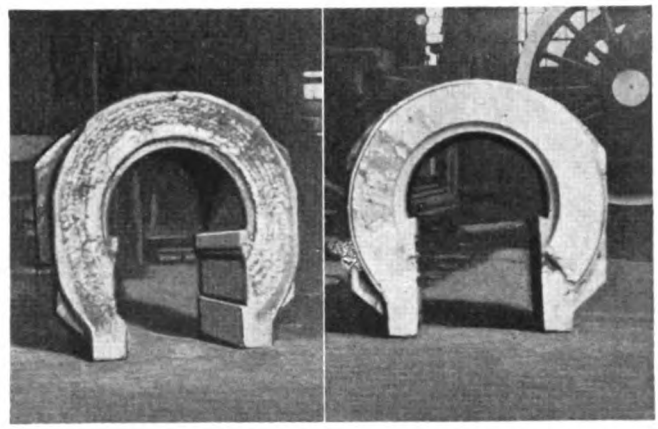
in. and the thickness of the flight is sometimes less than an ⅛ in. An easy way to handle this job, is to first turn the screw in a lathe to 1¼ in. under the finished size, which machining will cut away the very thin outer edge and make room for a strip of metal ⅝ in. square along the full length of the flight. The operator then places the screw on horses about the height of a work bench and heats and bends the square strip a few inches at a time; afterwards he tacks it in position. This will take perhaps a couple of hours. The screw is then stood on end so that the welder can complete the welding in a down-hand position. The amount of rod used and the time it takes to finish the job vary with the amount of wear, the average time being somewhere in the neighborhood of 18 hr. per screw.

The conveyor screw presents an entirely different problem, the most wear coming in the crusher zone, both on the hub and the flight. The welding of this job is similar to that described for the elevator screw.

Welding Driving Boxes

Most railroads in the East met with no little disappointment when the bronzing of driving boxes was first attempted. Poured bronze liners have always given trouble; they either wear too fast or break and fall from the box. Bronzing these boxes with the torch was expected to cure these troubles, but although the welded liners did not fall off they did not give satisfactory wear. The shop where the author is employed gave the matter considerable thought before attempting to braze driving boxes. The method finally approved has proven highly satisfactory and is now a standard practice. Following is a brief sketch of the procedure:

The box is first cleaned thoroughly, then the groove,



Left: Driving-box face welded with coated rods to act as a base for the bronze liner—Right: The box after brazing on the bronze liner

originally machined to hold the poured liner, is filled to the top by arc welding, using ⅜-in. coated rod. Numerous other methods have been tried, such as filling these grooves with small pieces of plate and welding them with bare rod or making a plate to fill the entire groove and welding it in place; however, filling the box solid with coated-rod welding has proved to be entirely satisfactory. After the box is built up to its proper height, the surface is thoroughly ground to remove all scale and flux. Then a piece of 3/16-in. by ½-in. soft steel is bent and tacked to the top outside edge to act as a dam for the bronze when it is applied. It is believed that the successful performance of these boxes is due to the solid base, made by the shielded-arc electrode.

The foregoing are just a few of the applications of coated-rod welding. Every day new opportunities arise where it can be used to better advantage than other methods. Some of them include driving-wheel felloes and spokes, pedestal caps, car side frames and bolsters.

In conclusion mention should be made of the use of coated rods on vertical welds with which numerous operators have considerable trouble. It can be overcome with a little practice and the proper procedure. Striking the arc at the bottom of the vee, the operator should move the rod up as rapidly as possible, taking care not to oscillate the bead more than one and a half times the diameter of the rod as the flux becomes fluid. As the molten metal is about to run back down the vee, the rod should be moved quickly up and away from the molten flux but the arc should not be broken, because the puddle will solidify while it is still red. After the bead is completed the welder should then come back and start welding again. This same procedure is followed up the entire weld, using the same method for each successive bead until the vee is full.

Air Reservoir Cleaning Machine

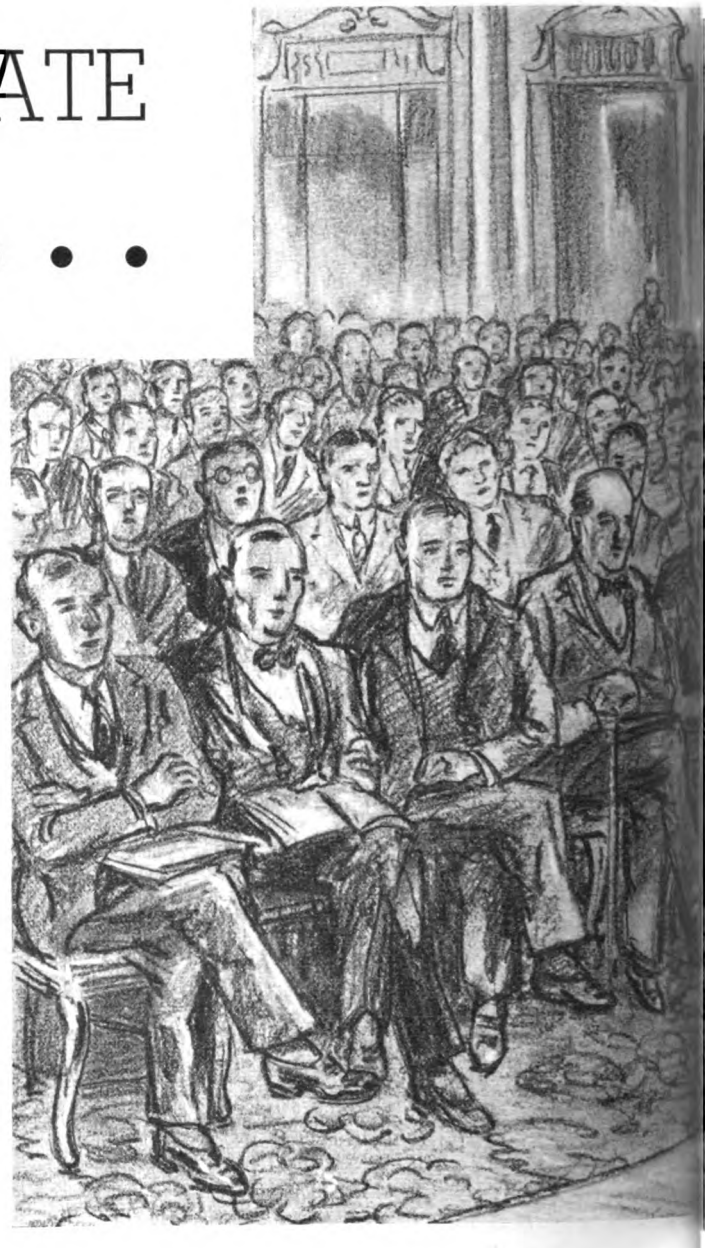
The use of the reservoir cleaning machine, illustrated, has greatly reduced the possibility of any oil, dirt or rust accumulating in reservoirs and being carried back to brake system. Simple in construction and operation, this machine permits the thorough cleaning of reservoirs and, if desired, the spraying of the inside with paint.

Reservoirs found by inspection to require cleaning are moved to the boiler shop where this machine is located; a solution of soda ash is prepared; and if, upon inspection it is thought necessary, several short lengths of ½-in.

(*Continued on page 389*)

NEVER TOO LATE TO ATTEND . . .

***by* Walt Wyre**



THINGS had not been going well for several weeks in the S. P. & W. roundhouse at Plainville. H. H. Carter, master mechanic of the Plains Division, was beginning to be worried. It wasn't any one thing wrong that the master mechanic could lay his hands on, but a flock of little troubles, the kind that individually seem too unimportant to notice, but taken all together can cause more annoyance than sand fleas on a bathing beach. Five- and ten-minute delays getting locomotives out on the lead, a little more overtime than seemed warranted. . . .

The men in the shop didn't seem interested in the work. Carter sensed rather than saw the latter. All of it added up one thing. If the condition continued to grow, as it would unless checked, the mechanical department of the Plains Division was heading for trouble.

Carter sat in his office and doodled as he pondered. Doodling is doing something in an abstracted manner while the mind is too busy on something else to notice. Carter's pet form of doodling is drawing triangles of various shapes and sizes. He covered all the blank paper on his desk with triangles, then reached for the phone and rang the roundhouse office. "Tell Evans to come to my office," the master mechanic said.

While waiting for the roundhouse foreman, Carter picked up a magazine devoted to railway mechanical departments and began thumbing through. By chance he opened the magazine at the editorial page:

> "Every mechanical foreman that possibly can should attend the forthcoming organization meeting. Exchange of ideas, learning methods of other men and railroads and seeing the latest developments in equipment and machines are not the only benefits to be derived from attending such meetings—"

The master mechanic drew triangles on the margin of the magazine as he read the editorial.

"Want to see me, Mr. Carter?" Evans asked a few minutes later.

"Yes, sit down, Jim." The master mechanic indicated a chair across the desk. "You've been roundhouse foreman here quite a while," Carter began.

Evans fidgeted nervously. "Yes, I've been on the job a good many years—maybe too many."

"Ever been to a convention?" the master mechanic interrupted somewhat abruptly.

"No, been too busy. I was elected delegate to attend a Lions' convention once—that was in 1928 when we got the 5000's—and I didn't go."

"How's the overtime showing up for the month."

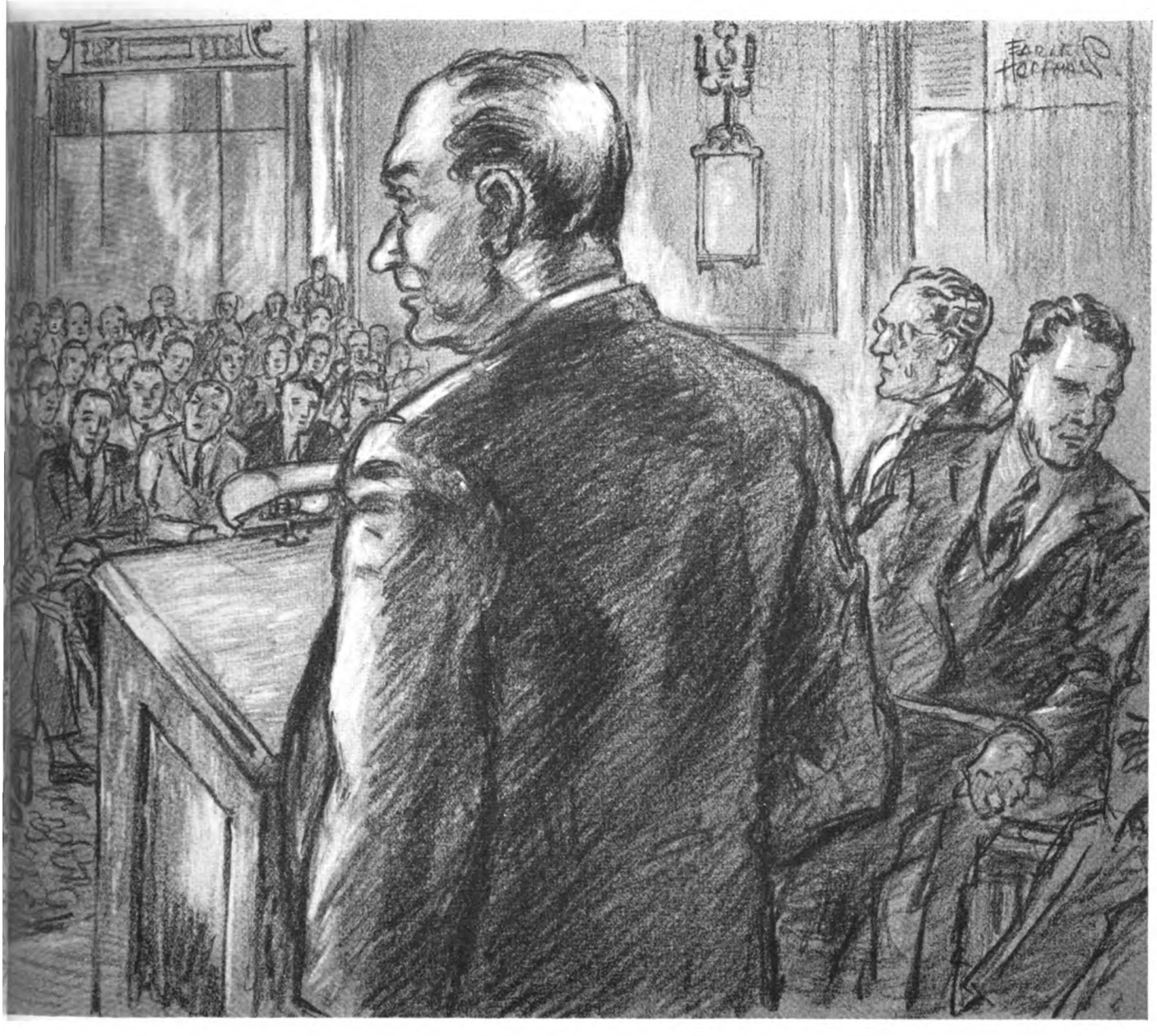
Evans gulped so hard he almost swallowed his chew of "horseshoe." Somebody in the room was screwy. He pinched himself to see if he was awake. "Well, er—"

"Not so good," Carter finished, "and engine performance is not so good either. I think it's about time you went to a convention."

Evans blinked and pinched himself again, harder than before. Someone should call the nut-wagon before Carter became violent, or maybe it was the other way 'round. At any rate at least half of the people in the room needed a quiet room with cushioned walls. Mrs. Evans had been telling him that job was going to drive him crazy if he didn't quit worrying about it. But he didn't feel any crazier than usual. Maybe it was the master mechanic after all. He had lots of worries too. Evans decided to humor him.

"Yes, everybody should go to a convention occasionally. I've been planning to attend one when I can find time."

Carter laughed uproariously. "If I didn't know you so well, Jim, I'd think you were trying to kid me. And I don't blame you much for thinking me crazy. Here, read this." The master mechanic pushed the magazine across the table and pointed to the editorial.



Jim doesn't know yet how he negotiated the miles of carpet between his seat and the platform, but he made it

"What do you think of it?" Carter asked when Jim had finished.

"Well, those meetings are all right I guess for people that have time to attend them. If conditions in the shop weren't so bad I'd kinda like to go."

"That's just the reason I think perhaps it would be a good idea for you to go. I've been trying to figure out just what's wrong in the shops and I've just about reached the conclusion that the trouble lies with you."

Evans winced. "Well, I must admit things haven't been going as well as they should, but I've been trying—"

"Maybe you've been trying too hard, and it's getting on your nerves. When a foreman gets jumpy, it has a bad effect on the men. They get nervous too." Carter smiled and Evans felt better.

"And you would like for me to attend the mechanical department foremen's meeting?"

"Just a suggestion." The master mechanic smiled again. "Why not take the wife along? There's always some kind of entertainment for the ladies."

"If you think the shop can get along," Jim said.

"Sure, we'll get along somehow. Better take out tomorrow at noon—and forget the shops at Plainville until you get back." The master mechanic picked up a letter when Evans started to thank him.

When Evans went back to the roundhouse he was whistling softly to himself. His whistle hadn't been used much lately and sounded slightly off key, but he didn't mind. The sound of Evans' whistle was drowned by locomotive blowers and other noises when he entered the roundhouse, but it didn't drown the look of good humor on his face as he walked through the house whistling with his mouth and smiling with his eyes.

Everyone in the roundhouse was working when the foreman went through, or, to be more exact, everyone was putting in time and going through the motions of working. A machinist was fitting a knuckle pin bushing with the enthusiasm of a small boy washing his neck. The nut-splitter's helper was leaning indolently on a buggy bar. When the two men saw Evans they straightened up like convicts when the guard comes near.

"Well, how's it going?" Evans requested cheerfully.

"Fine, Mr. Evans," the mechanic smiled.

Before the foreman was out of sight the machinist and helper were working, not like convicts serving a sentence, but like the skilled men they were and proud of it. Neither they nor the foreman realized that any change had taken place, but five o'clock came quicker and more work was done.

It was the same way all through the roundhouse. Motivated by the same invisible force, everyone worked more cheerfully, and there was no overtime that day.

"How would you like to go to a convention?" Evans asked his wife that evening.

"Me—go to a convention! What kind and where?"

"It's a mechanical foreman's meeting," Evans explained. "I'm going and thought maybe you'd like to go along."

"Jim Evans, are you crazy? Starting to go to conventions at your age! You know all they do at conventions is get drunk and raise Cain in general. Humph! You must be getting in your second childhood. Sit down and eat your supper before it gets cold. You'd look good with a dunce cap on and blowing a paper whistle!" Mrs. Evans snorted again.

"Not getting old, are you, Mom?"

"Of course I'm not getting old and don't call me Mom! If you're bound to start acting foolish I'll go with you." Mrs. Evans didn't succeed in her attempt to act peeved.

WHEN Evans and his wife reached the city, Jim was just a little troubled about where to go and what to do when he got there. The first thing was to get a room. Beyond that his ideas were somewhat hazy. Like most other people, he didn't want to appear either ignorant or foolish, as he was afraid he would if he started asking questions.

The two stood in the huge waiting-room of the central station when some one slapped Evans so hard on the back he almost dropped the bag he was carrying.

"Why, if it ain't Jim Evans! You old son-of-a-gun!"

Evans dropped the bag and grabbed the proffered hand. "Why, Charley Drake! Where in the—I mean where have you been keeping yourself! I haven't seen you in twenty years." Evans was so tickled he didn't think to introduce his wife until she pinched him on the arm.

"Oh, yeah, excuse me, meet the wife. Charley and I worked together twenty years ago on the MOP."

"Well, I was on my way to the hotel. Where are you stopping?"

Evans confessed they hadn't decided, but guessed the one where Charley was staying and where the meetings were to be held was good as any.

"O.K., let's go," Drake said. "The Missus is waiting for me. When I first started attending these meetings she wouldn't come with me. Three years ago I made the mistake of persuading her to come along and now I can't get her to stay away."

Jim and his wife were both relieved. He would have someone that knew the way to steer him and Mrs. Evans wouldn't have to sit around the hotel alone.

It was 3:30 in the afternoon when Evans and his wife reached the city and a little after four when they reached the hotel with Charley Drake.

"Do you have any plans for this evening?" Drake asked when they arrived at the hotel.

"No-o," Evans said, "thought maybe we might go to a show or something."

"What you say we have dinner together. Mrs. Drake will be with us and let the women go to a show and we'll take in the exhibits," Charley suggested.

"Why can't we all look at the exhibits and then go to a show together?" Mrs. Evans amended.

The two couples had dinner together and went to see the manufacturers' exhibits together, but the wives went to the show alone. The women couldn't drag Evans away from the exhibits and Drake only lent half hearted assistance in the attempt.

At first the ladies enjoyed the exhibits as much as the men. The brilliantly lighted hall filled with shiny machines and appliances was a show worth any one's time. Electrical displays worthy of a world's fair added color to the exhibition.

"Best they've ever had," Drake remarked.

"Uh-huh," Evans replied without looking up. He was too busy watching a working model of a Diesel-electric power unit to pay attention to anything else.

The model, complete in every detail, was an exact replica of ones the S. P. & W. were getting. Jim, long versed in steam, had read some about the new trains but without understanding much about them. The working model with lighted interior and glass windows told the mechanical minded Evans more in five minutes than he could learn in hours of reading. When he had finally figured to his own satisfaction how the Diesel electric worked, they got him away.

"That's the thing that's going to do away with steam power," Drake remarked.

"Not on your life," Evans disagreed. "They're all right for light trains and high speed, but for heavy transcontinental service you can't beat steam. Now here's something!" Jim stopped like a bird dog that had almost over run a covey and came to a point. The something was a working model of the latest high speed innovation in steam locomotives. The four-cylinder motors operating driving wheels were operated by compressed air.

The ladies gave up and went to a show leaving Jim and Charley to continue their argument alone. They were still arguing when their wives returned over two hours later.

NEXT morning Charley escorted Evans to the registration desk and thence to the assembly room for opening of the meeting.

In the assembly room Jim met half a dozen men that he had known before. He was enjoying renewal of acquaintances so much that the chairman's gavel rapped too soon to suit him. He seated himself prepared to endure three hours of boresome talk.

Opening preliminaries were somewhat dull, but the speech that followed wasn't. "Personal Relations between Supervisor and Men" was the subject and the speaker knew it well. Moreover, he could tell it in an interesting manner. Before the speech was finished Jim, along with most of the others, was leaning forward with interest.

The meeting didn't drag as Evans had expected it would. Some of the speakers were a little dull but all knew their subjects well.

That evening they had dinner on the roof garden followed by an informal dance and a floor show. Mrs. Evans even persuaded Jim to dance. After he got limbered up she had to persuade him to stop.

The first day of the convention was interesting but it didn't really get going good until the second. Discussion of various problems by members interested Evans most. When they started talking about lubrication, valve setting, and such things he was right at home. A couple of times he even managed to get up nerve enough to express an opinion on the floor. When he did he held

on to the back of the chair in front of him so no one would notice his hands shaking and he hoped the tremor in his voice wasn't noticeable. When they started discussing the use of fuel oil in locomotives, apparently few knew much about it. There were more questions than answers on the subject.

"Well, it seems we are going to have to carry the subject over," the chairman announced. "We don't seem to be getting anywhere."

"Mr. Chairman," Charley Drake rose and was recognized, "we have with us a new member that I believe could give some information on the subject of using oil as fuel for locomotives. They have been using oil where he is located several years and very successfully, I understand. I'd like to have Mr. Jim Evans of the S. P. & W. say a few words."

The cheering had almost subsided before Evans realized it was for him. He rose and stood shaking like an aspen in a storm.

"Come up to the platform, Mr. Evans," the chairman requested.

Jim doesn't know yet how he negotiated the miles of carpet between his seat and the platform, but he made it. Stammering and hesitant, he began telling of the various troubles they had experienced when the S. P. & W. began to use oil and how they were corrected. His embarrassment wore off as Evans warmed up to his subject and returned only when the crowd cheered loud and long at the conclusion of his talk.

"Boy, I knew you had it in you, but didn't know you could get it out," Drake complimented when Evans returned to his seat.

The meeting ended with a banquet and dance. Evans wore a fringed and tasseled fool's cap and blew lustily on a paper whistle that unrolled like a snake, but his wife didn't laugh at him. She had on a cap that topped his by four inches or more and had little bells around the edge that tinkled when she moved her head. If that wasn't noise enough she had a horn that sounded like the bellow of a dying calf.

"How did you like the meeting?" the master mechanic asked when Evans was back in Plainville.

"Fine. Had a wonderful time and learned a lot of things."

"How did Mrs. Evans like it?"

"Just try to keep her away from the next one," Evans replied as he started towards the roundhouse office.

Starkey, the general foreman, was in the office when Jim got there. "Well, I guess you had a nice time at the convention," the general foreman said after they had exchanged greetings.

"Yes, I'm glad the master mechanic suggested my going. Wonder how he came to think of it."

"Was peculiar," Starkey said, but he didn't say that he had left the magazine on the master mechanic's desk open at the editorial.

Starkey wanted to go to the meeting himself.

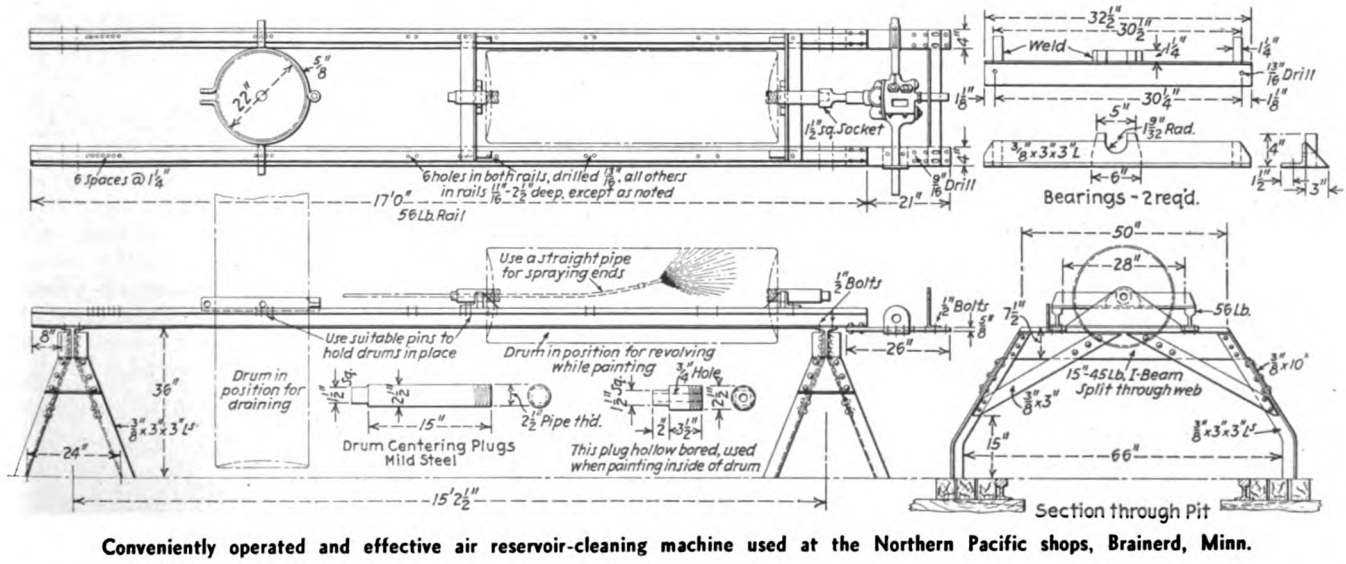
Air Reservoir Cleaning Machine

(*Continued from page 385*)

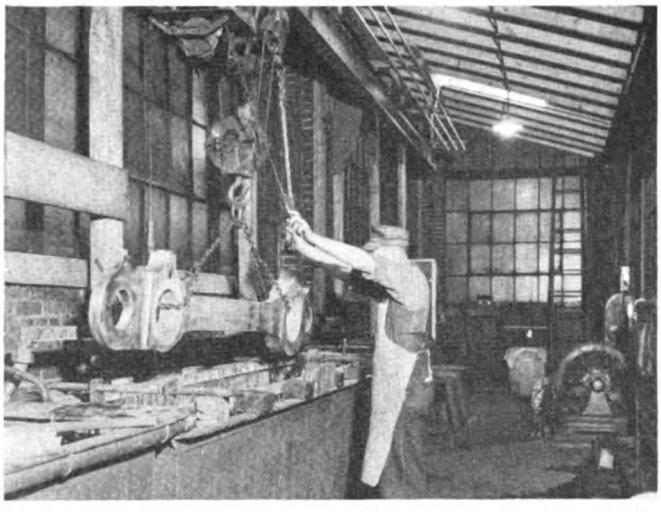
chain are placed in the reservoir to aid in removing scale or rust. Two centering plugs, one in either end, are applied to the reservoir. One of these plugs has a ¾-in. hole through the center to permit spraying the interior; the other is arranged to fit an air motor used to rotate the reservoir. Soda ash solution is poured in the reservoir and the reservoir placed on the machine in a horizontal position. The end plug is fitted to the air motor held by a bracket at one end of the machine. The machine is then set in motion, the reservoir being revolved by the air motor, and allowed to run for from 60 to 90 minutes.

A clamp, shown on the drawing, is then applied and the reservoir is hung in position for draining and removal of the chains if used, after which the reservoir is flushed with hot water and allowed to dry. If desired, the reservoir interior may be sprayed with paint, the reservoir being placed in position for turning by air motor while this is being done. This reservoir-cleaning device straddles a pit to permit quick disposal of the water used, the machine being composed of two horses, spaced 15 ft. 2½ in. apart, on which are bolted two 17-ft. sections of 56-lb. rail. Holes are drilled in the top of the rails for pins used in locating and holding in position the reservoir being cleaned or drained.

Two bearings or guides are used in supporting the reservoir by centering plugs while being turned by air motor. A bracket supports the air motor during the operation. Other equipment required includes the paint sprayer, if used. This machine is used at the Northern Pacific shops, Brainerd, Minn.



Conveniently operated and effective air reservoir-cleaning machine used at the Northern Pacific shops, Brainerd, Minn.



A portion of the equipment used for zinc-plating locomotive rods is shown here

Zinc Plating Locomotive Main and Side Rods

The zinc plating of locomotive main and side rods is done to prevent corrosion and make it easier to keep the parts clean. Owing to the fact that the plating is only .004 in. thick, there is no possibility of the process concealing cracks or flaws.

The plating and cleaning tanks used are made of iron, 2 ft. wide, 2½ ft. deep and 16 ft. long. Four tanks are required, one for cleaning with the use of an alkali cleaning solution and reversed electric current; one tank for rinsing and two for plating. The plating tanks are provided with heater coils inside, and the tank is insulated on the outside. One of the most important factors in electro-plating is that the surface to be plated must be absolutely clean.

Parts to be zinc plated are first sand blasted lightly, cleaned, rinsed and then plated. After the plating process has been completed the surface is sponged with a soap solution, then burnished with a steel wire power-driven hand buffer. The plating tanks should be arranged in one line and served by a two-ton traveling electric hoist.

The plating tank has a capacity of 570 gallons of solution and contains 432 lb. of zinc anodes distributed on both sides to suit the long material being plated. The temperature of the solution is kept at 85 or 90 deg., and is kept up to full strength by adding sodium cyanide ($\frac{1}{12}$ ounce per gallon) and caustic soda ($\frac{1}{24}$ ounce per gallon) for each eight hours of plating. The following formula for zinc plating of rods has given excellent results on one road for some time:

Zinc cyanide	5 to 7 oz.
Sodium cyanide	3 to 5 oz.
Caustic soda	4 to 8 oz.
Water	1 gallon

A 2,500 ampere capacity generator is used for plating. The current is 25 to 30 amperes per square foot of surface plated, with a voltage of from 4 to 6. Special provision has to be made to take care of the cyanide fumes generated in the plating plant. This can be done by the installation of ventilating fans which exhaust fumes from the tanks to the atmosphere.

Main and side rods plated in this manner will not have to be replated when the locomotive returns to the shops for classified repairs.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Why Are Waist Sheets Used?

Q.—Why are waist sheets used on a locomotive? Should the bolts securing the waist sheets be applied from the waist-sheet side?—R. K.

A.—The reason for applying waist sheets on a locomotive is to support the frames against the forces tending to buckle them longitudinally. These forces are resisted through the waist sheets by the rigidity of the boiler. Plates are used for this purpose to provide the necessary flexibility to compensate for the fact that the boiler expands and contracts while the frames remain rigid.

Waist sheet bolts should be applied from the waist-sheet side so as to obtain a full bearing area on the bolt. The waist sheets are generally from ½ to ⅝ in. thick. Should the bolts be applied through the waist-sheet crosstie with the nuts on the waist-sheet side, the threaded end of the bolt would be in the waist sheet, thus reducing the bearing area considerably.

Loss of Flow in Pipes Due to Application of a Valve

Q.—What effect does the application of a valve in a steam or water line have on the quantity of steam or water delivered through the pipe? Can it be computed for a given condition?—C. G.

A.—The discharge of water through globe valves under a given flow pressure depends primarily upon the type of valve considered. The Crane Company has conducted a series of tests with various types of globe valves in sizes up to and including 2½ in. and has determined that the flow through a globe valve is, roughly, one half of the flow through a short pipe of the same size. Thus, the addition of a valve in any line will cut down the flow if there is no increase in pressure head.

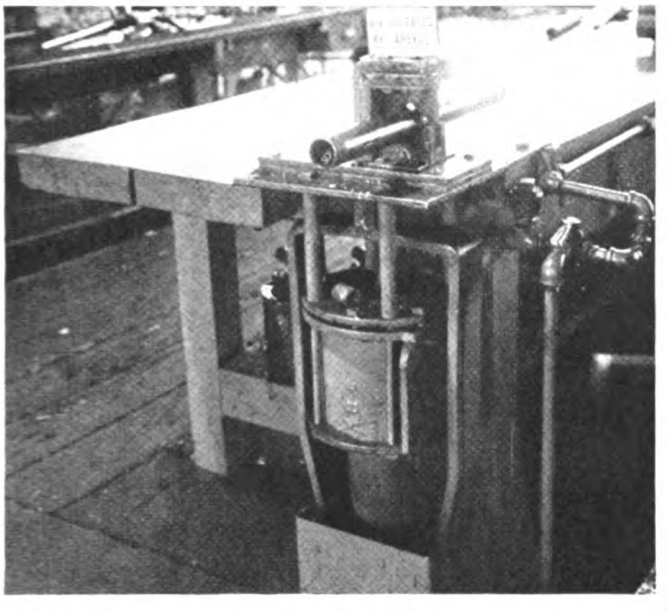
Formulas for the flow of water or steam through pipes can be obtained from any engineering handbook.

How to Repair a Cracked Flue-Sheet Knuckle

Q.—What is the proper way to repair a cracked flue knuckle? Should it be welded on the fire side and also on the water side?—S. A. W.

A.—The proper way to repair a cracked flue knuckle is to apply a new top portion of the sheet by riveting and welding, or to apply a knuckle patch extending down and taking in one row of superheater flues. When it is desired to keep a locomotive in service until it can be held for repairs, horizontal knuckle cracks can be cut out and welded from the water side.

With the Car Foremen and Inspectors



Air-operated pipe vise used at the Milwaukee passenger car shops of the C. M. St. P. & P.

Air-Operated Pipe Vise

While the idea of an air-operated pipe vise is not especially new, the particular design shown in the illustration is unusually simple and compact, giving good results at the car-department pipe shop of the Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis. Since firm tightening and subsequent release of hand vise pressure is no small part of the labor of cutting and threading pipes, the device is a substantial time and labor saver. In fact, the increased efficiency with this power vise is such that as much work can be done with it as would be possible with two or more ordinary hand vises. The device, therefore, saves bench space, as well as time and labor.

The air-operated vise used at Milwaukee shops consists simply of conventional pipe jaws, the lower one of which is mounted at a convenient location on the pipe bench and the upper jaw set in a vertical-operating steel member which is moved up and down by means of an air cylinder underneath the bench. The ½-in. steel plate which supports the vise and its operating parts is 18 in. long by 14 in. wide, being bolted securely in one corner of the pipe bench. Two additional ½-in. by 6-in. by 14-in. steel plates, inserted under the lower jaw of the vise, serve to stiffen the construction. The 8-in. air brake cylinder which operates in an inverted position underneath the bench is supported from the steel corner plate by four ½-in. through bolts and four ¾-in. pipe nipples, 7¾ in. long. A yoke made of $1\frac{1}{16}$-in. by 3⅜-in. steel is connected to the push rod at the lower end, passes around each side of the air brake cylinder and is joined at the top in a single 1⅜-in. by 3⅜-in. steel upright which passes through a suitable guide hole in the supporting plates and is bent at right angles, 10¼ in. above the bench top, where it serves to support the upper vise jaw.

It is obvious that operation of the air-cylinder piston and push rod by means of the three-way valve, shown at the right in the illustration, moves this yoke and the upper jaw of the vise up and down as may be required in clamping a pipe. A grease cup, used in lubricating the cylinder, is shown just at the left of the operating valve. An important feature is the provision of a thin sheet metal guard around the base of the vise to make sure that the pipe fitter does not accidentally get his foot caught between the floor and the descending air cylinder push rod and yoke which would be sure to cause a painful injury.

What Is An Accident?

By P. F. Buckle*

It is my belief that we use the word "accident" too frequently and without giving thought to its meaning. Webster's definition of the word is to the effect that it is an occurrence unforeseen and, therefore, unavoidable, whereas an outstanding railroad safety officer defined "accident" as being something that occurs because a hazard was permitted to exist until the accident occurred. And when I use the term "hazard" I mean not only hazards in physical property but hazards due to following improper practices.

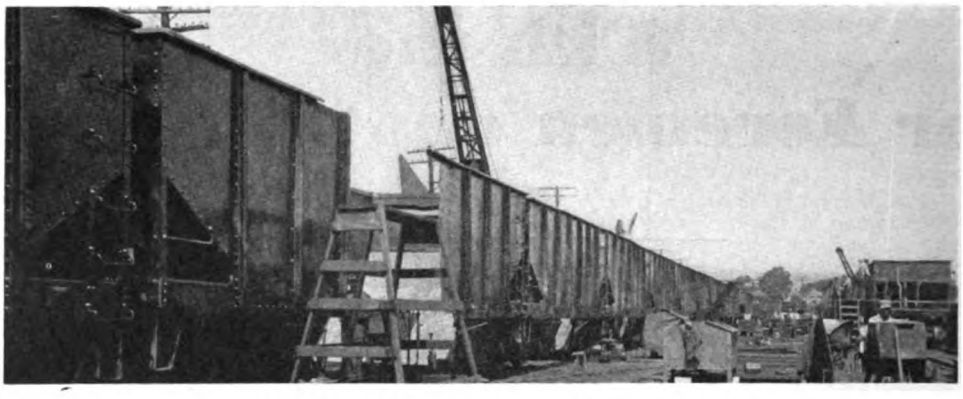
Please think about that, and at the same time remember that the members of your organization will largely do what you want them to if they can find out what it is you wish done. If a supervisor knowingly permits a hazard to exist and because of that an injury results, isn't he just as guilty, if not more so, than the man receiving the injury?

Let me illustrate: Probably the most important rule providing for the protection of car workers is the blue flag rule, and I am going to tell you of two violations of that rule. One of these resulted in death; the other did not, but the potential risk was there, just the same.

A carman, at night in bitter cold weather, was coupling the hose between the first and second cars of a passenger train as it stood ready to depart from a terminal. The train was late, and the outgoing road engine had picked up a baggage car and backed down on the train. The

(*Continued on page 395*)

* The accompanying article is a brief excerpt from an address "Prevention of Personal Injury in the Car Department," delivered at the September 12 meeting of the Car Foremen's Association of Chicago by Mr. Buckle, who is superintendent of safety, Chicago, Burlington & Quincy.



Part of the rebuilding tracks and the Sayre shop of the Lehigh Valley showing the line of cut-down cars



Fig. 1

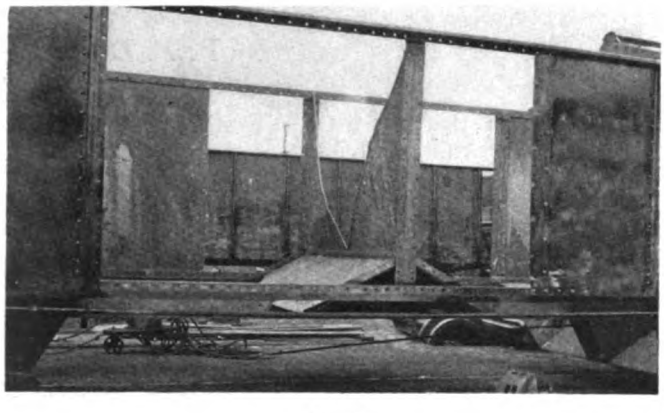


Fig. 2

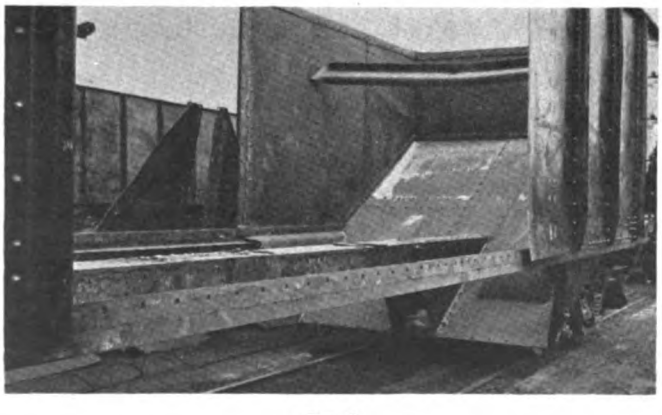


Fig. 3



Fig. 4

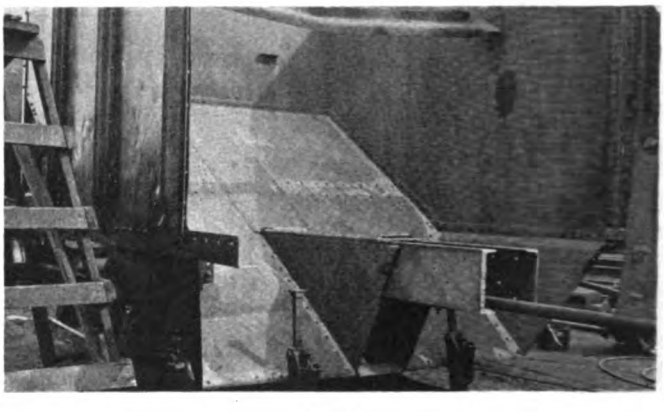


Fig. 5

Fig. 1—One of the 70-ton cars before the cutting operations have been started; Fig. 2—The car at its original length before the center member has been removed and before cutting the top bulb angle and center sill; Fig. 3—The center member is out and the side sheets have been cut. On the far side of the car the side sheet has been cut three panels from the end of the car and on the near side the cut has been made four panels from the end; Fig. 4—The cross hood and center bracing is removed and installed in the rebuilt cars; Fig. 5—This shows how the center sill top cover plate is cut at a point 36 in. from the cut in the sill channels.

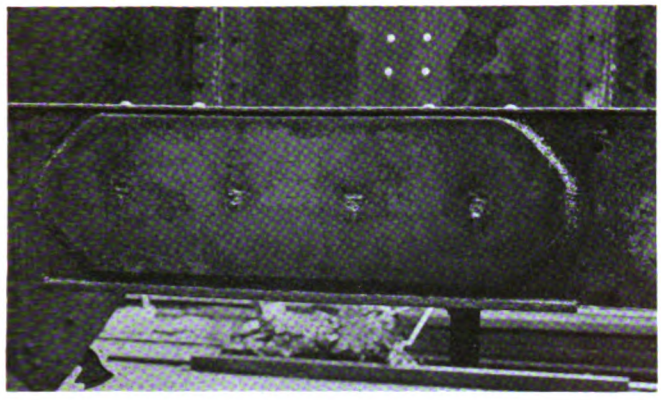


Fig. 6

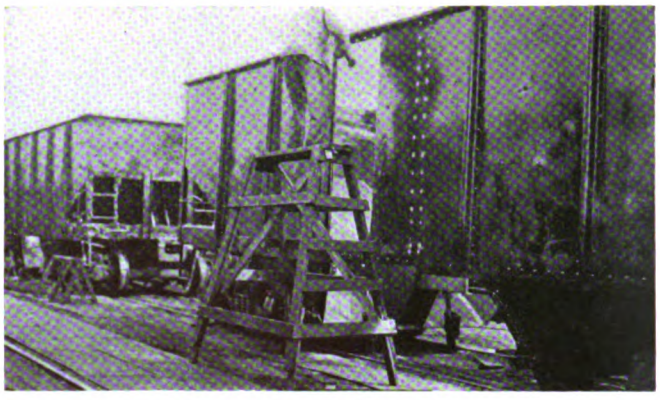


Fig. 7

Lehigh Valley Cuts Down 70-Ton Hoppers to 50 Tons

In order to meet a demand on the part of present-day coal shippers for hopper cars of 50 tons' capacity the Lehigh Valley is now in the course of a car-rebuilding program at its Sayre, Pa., shops, part of which is the cutting down of a total of 500 hopper cars of 70 tons' capacity. The original 70-ton car had a light weight of 47,700 lb. with a maximum capacity of 2,833 cu. ft. and 73 tons of coal. It had an overall length inside the sheets of 40 ft. and was equipped with four-wheel trucks of modern design with cast-steel side frames and rolled-steel wheels. The rebuilt car has a light weight of 40,600 lb. with a capacity of 1,928 cu. ft. and 50 tons of anthracite coal. The original trucks from the 70-ton cars are rebuilt and placed under the 50-ton cars.

The interesting part of the rebuilding operation is the fact that the old cars are virtually cut in two in the middle and pushed together to form a new car. The old cars were 10 panels long and the rebuilt cars have only seven side panels with an inside length of 28 ft. 4 in., there having been 11 ft. 8 in. cut out from the center of the car. Material removed from the car is usable and is refabricated for making up various parts to be used on 50-ton steel hopper cars undergoing general repairs. In order that there be no weakening of the car structure the cuts in the side sheets, top angles, side sills and center sills were staggered diagonally across the car so that no cut in any member is in line, transversely, with any other cut member. The cut in the top bulb angle on one side of the car is made 8 ft. 7 in. from the corner of the car and a section 11 ft. 8 in. is taken out. The side sheets on that side of the car are cut 15 ft. 7 in. from the same corner, and the same section is taken out from them. The first cut in the channels



Fig. 8

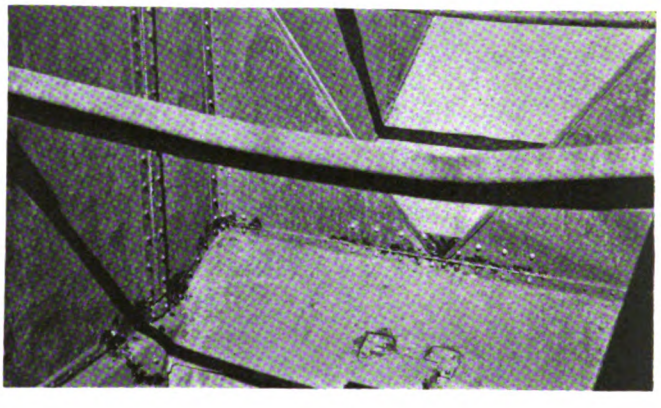


Fig. 9

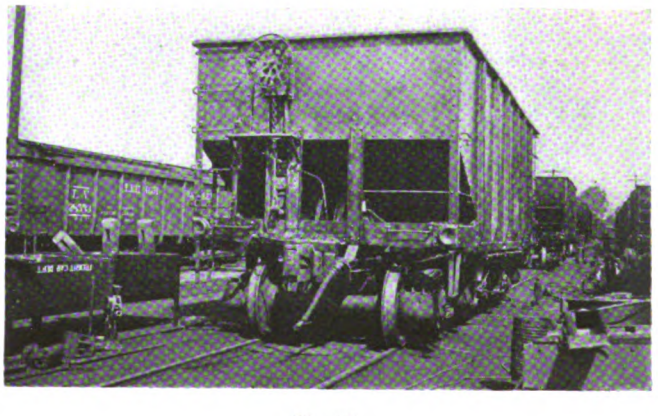


Fig. 10

Fig. 6—The patch on the side of the center sill; Fig. 7—The ends of the car are being pushed together—one end is fixed and the other is moving; Fig. 8—Special dollies and wedges under the hoppers of the moving end of the car maintain the height so that the parts will go together properly; Fig. 9—At this stage the ends have been pushed together and the cross hood and center bracing has been riveted in; Fig. 10—The rebuilding operations have been completed and the car is ready for painting.

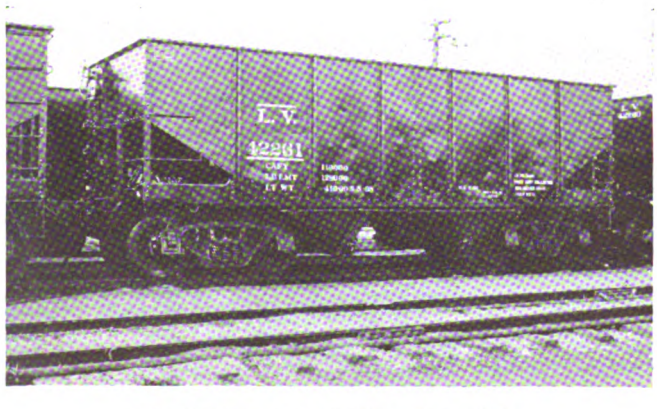


How the center sill cover plate was cut

of the center sill is made 11 ft. 2 in. from the same end of the car and the top cover plate is cut and turned back to allow material for fitting into place and cutting after the ends of the shortened center sill have been put together and welded. The inside hoppers are removed. The outside hoppers remain intact and become the two hoppers for the rebuilt cars.

Before the supporting members of the center of the car are finally cut away the remaining end hoppers under one end of the car are supported by two small dolly trucks which roll on the standard-gage yard tracks so that as the one car end is pulled by a power winch toward the other, or fixed end, the two ends are maintained at exactly the proper height to insure their coming together so that the rivet holes in the splice plates and at the ends of the side sheets adjacent to the cut-away portion will match.

Where the center sill has been cut it is strengthened by a patch on both sides made of ½-in. plate 10½ in. wide and 36 in. long. This patch is welded to the center sill on all sides. A ½-in. by 15-in. by 36-in. patch plate is also welded onto the bottom of the center sill. This center-sill construction of the rebuilt cars meets all of the requirements of A. A. R. Standard Practice. Before the actual rebuilding program was started a test car was operated in service for several months and subjected to all manner of unusual conditions in an effort to develop any weak spots if any existed. The output of the rebuilding line averages six cars a day.



The finished car, painted and stenciled

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Claims of Excessive Labor Charges And Unauthorized Repairs

On April 26, 1935, Florida East Coast car No. 17,496 was damaged to the extent of Rule 44 in switching on the Clinchfield at Kingsport, Tenn. The car, with load, was interchanged to the Chesapeake & Ohio at Elkhorn City, Ky., and returned empty to the Clinchfield on May 24, 1935, where it was repaired the next day.

The car was received on the home line July 4, 1935, and on September 18, 1935, the owner furnished a joint inspection certificate covering certain items of damage and wrong repairs which were found to exist, with the request that a defect card be furnished by the Clinchfield to cover these items. The Clinchfield furnished its defect card under protest to cover part of the items listed on the joint inspection, as follows:

A—Two metal center sills bent and not properly straightened

A—Two metal side sills bent and not properly straightened

CR—Two side sill splice plates omitted
Two center sill splice plates wrong—not proper thickness

The owners made repairs on December 9, 1936, and a charge, on authority of the above mentioned defect card, amounting to $345.97 was included in the car repair bill to the Clinchfield.

Upon receipt of the bill, exception was taken to certain charges, amounting to more than 10 per cent of the total amount of the bill, because the Clinchfield claimed more man-hours than necessary were used for straightening the side and center sills. The handling line claimed that the car was not in the condition reported on the joint inspection certificate when it left the Clinchfield, as evidenced by the fact that it moved to a communicating line without exception and moved considerably during June before moving to the home line in July.

The Florida East Coast pointed out that the Clinchfield admitted making no record of the damaged sustained at the time of the accident. The owner showed that during an interim of five days the car was moved 136 miles and that repairs were made by the Clinchfield, as stated in the joint inspection certificate. The owner claimed this work could not have been accomplished during the five-day period. When repairs were made on the home line, an accurate record of man-hours used was kept and the owner stated that its bill represented the actual number of hours that employees were engaged in performing the work, and substantiated its statement with an original record of repairs.

In rendering a decision on November 11, 1937, the Arbitration Committee stated: "The Clinchfield should issue its defect card to cover all items shown in the joint inspection certificate dated August 30, 1935, and, since the charges contained in the repair bill rendered by the Florida East Coast are based on actual time and A. A. R. allowances for repairing the damage so covered, the bill should be paid as rendered."—*Case No. 1,760, Clinchfield versus Florida East Coast.*

(Turn to next left-hand page)



Behind every Chilled Car Wheel

Controlling design, composition and manufacture in our member plants, stands the Research Laboratory of the Association. Equipped for basic research, for practical tests, for investigations into every phase of wheel wear, its recommendations from cupola mix to final tests are made effective through our inspection system and its organization. This central laboratory has made a major contribution to the solution of many wheel problems.

ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS

445 N. SACRAMENTO BLVD.
CHICAGO, ILLINOIS

AMCCW

230 PARK AVENUE
NEW YORK, N. Y.

What Is An Accident?

(*Continued from page 391*)

carman, too late probably, became aware of what was taking place and raised up just enough so that his head was caught between the buffer plates. He never regained consciousness and died shortly. He had a blue light, but failed to hang it on the head end of the head car, an operation which would have required 30 seconds of his time. His failure to give himself the protection he deserved, as the rules required, resulted tragically. Can you, by the wildest stretch of your imagination, term this occurrence an "accident"?

The second instance: A carman was found working beneath a car of a passenger train being made up at a station. No blue flag was displayed, but the car foreman, who was standing at the head end of the head car, said that he was protecting the workman beneath the car. A little later the road engine backed onto the train, and before coupling was made, the foreman did call to the man beneath the car, who removed himself before the engine touched the head car. Imagine what might have happened had the attention of the foreman been distracted from the job at hand just before the coupling was made. This foreman was permitting, in fact sanctioning, an unnecessary hazard by following a bad practice, and that workman and others were being invited to disregard a most important rule, which practice, if continued, must eventually lead to disaster.

Remember this: So-called accidents result only because of an unfortunate combination or chain of circumstances, and the proper time to investigate all casualties in the interest of prevention is before they occur.

It is well to overhaul safety practices frequently to insure that they do not become antiquated, and this is particularly true in plants where no casualty records of long standing exist. Any safety policy which is five or more years old should be taken apart, dusted off and carefully examined to insure its not being full of cracks or crack-pot ideas. Some of the ideas which I eagerly embraced and accepted a year or so ago I have come to reject as being entirely unsound.

For many years we have talked, preached, harangued and written about the three E's of safety: engineering, education and enforcement. And, while no doubt they have been and still are vital essentials, yet I feel they are utterly valueless in any safety campaign unless you add another E to stand for *enthusiasm*. It is because of your unfailing enthusiasm that you have made such progress in reducing personal casualties within your respective organizations. Because of your individual enthusiasm you have enthused your personnel. This enthusiasm has led you to create more and more labor-saving devices which are ingenious in the results they obtain, and whenever you lighten the labor of a worker you lessen hazard exposure.

These remarks have been addressed to supervisors of all rank. Regardless of the position we occupy, we are all more or less supervisors, because if we are not now directing an organization we entertain the hope that some day we shall assume that responsibility, and to that end our greatest immediate responsibility is supervising and directing our own activity properly.

Emerson said, "Every man I meet is in some way my superior; and in that way I can learn from him." Let us be constantly on the alert to learn from others, not forgetting that the success of an organization is dependent upon complete co-operation between all elements of that organization.

Making Stock-Car Door Staples

By A. Skinner*

A convenient device used for making stock car-door staples is shown in the illustrations. The staple stock is first cut to the proper length, $5\frac{1}{16}$ in., from a bar of $\frac{5}{8}$-in. round soft steel. The straight pieces are turned down on each end for a length of $\frac{7}{8}$ in. to a diameter of $\frac{1}{2}$ in., then being taken to a small bulldozer equipped with suitable dies for making the necessary U-bend.

Referring to the illustrations, the construction of the forming dies is apparent. Die *A* is welded to one end of an angle bracket made of $\frac{3}{4}$-in. by $2\frac{1}{2}$-in. bar stock and clamped to the moving head of the bulldozer. It will be observed that the lower part of die *A* has a rounded end $1\frac{1}{8}$ in. in diameter and the upper part a half-round recess $2\frac{1}{2}$ in. in diameter. Stationary die *B*, clamped to the bulldozer base plate, also is a welded two-piece die, the lower part of which has a half-round recess 3 in. in diameter and the upper part drilled with two $\frac{9}{16}$-in. holes spaced $1\frac{3}{4}$ in. apart, on centers. Stop gage *C* is a metal block bolted to the bulldozer base plate,

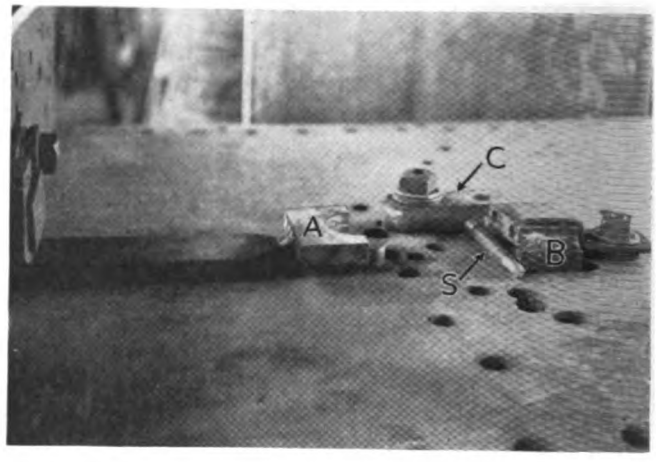


Fig. 1—Bulldozer die set-up for making the U bend in a stock-car door staple

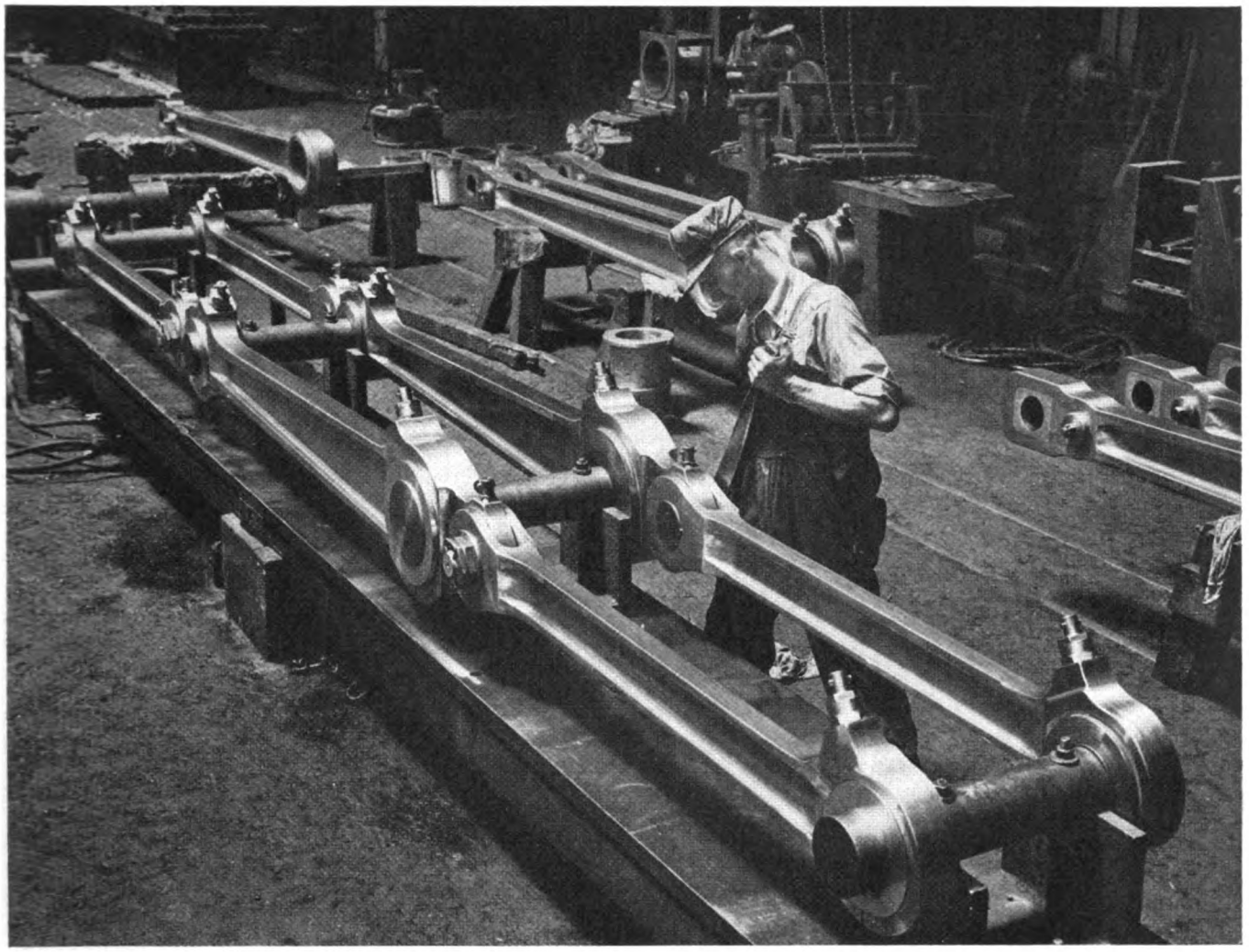
being used as a positioning piece to make sure that the bend is made uniformly at the correct location in each staple.

In forming stock-car door staples on a bulldozer, using the dies illustrated, the straight pieces of round-bar stock with machined ends are heated and placed one at a time, as shown at *S*, Fig. 1, resting against stationary die *B* and positioned lengthwise by block *C*. Operation of the moving head of the bulldozer forces round bar *S* into die *B*, giving it almost a full U-bend. On withdrawal of die *A*, the staple is removed by the machine operator using a pair of tongs; the staple sides are made practically parallel by a light hammer blow; the staple is inserted in the upper part of the die *A*, as shown in Fig. 2; and the second stroke of the bulldozer forces the machined ends of the staple into the holes in the upper part of stationary die *B*, thus making the staple ends accurately parallel and spaced $1\frac{3}{4}$ in. on centers. On the second return stroke of the bulldozer, the staple may be easily withdrawn and is then ready to be sent with others in a skid to the storeroom.

(*Continued on next left-hand page*)

* General Foreman, Atchison, Topeka & Santa Fe Reclamation Plant, Corwith, Ill.

METHODS AND MACHINERY THAT GUARD LIMA QUALITY



RODS ARE RIGHT

Rods are a vital part of the locomotive. Their correct fit means so much in reduced maintenance that Lima has introduced many refinements into their manufacture. » » » All machine work on rods is done with jigs so that the rods are accurate when completed. There is no fitting to be done when the rods are applied. They are set up in the shop on an assembly jig which makes sure of the complete interchangeability of rods on the same group of locomotives. » » » This care in rod manufacture is one reason why Lima-built locomotives "break in" easily.

LIMA LOCOMOTIVE WORKS LIMA LOCOMOTIVE WORKS INCORPORATED INCORPORATED, LIMA, OHIO

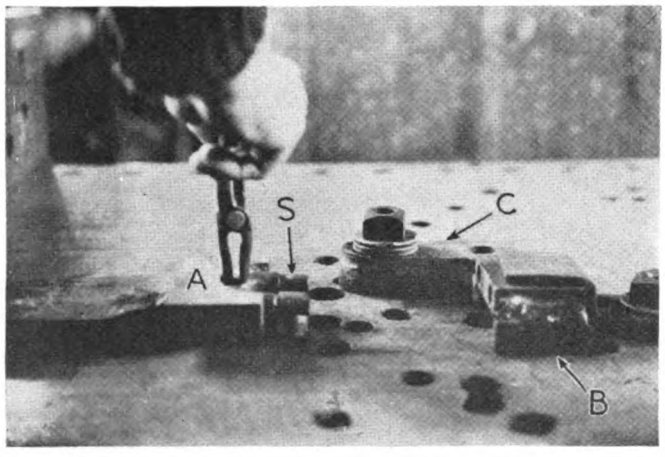


Fig. 2—On the second stroke of the bulldozer the machined staple ends are made parallel and spaced the correct distance apart

As finally used in stock-car doors, these staples are applied with the machined ends accurately fitting suitable holes in ¾-in. by 3½-in. by 10-in. steel plates, and the extreme ends which project through the plates are riveted over to provide a strong and permanent staple connection.

Repairing Angle Cocks At Milwaukee Shops

By Thos. H. Birch*

The various machines used in repairing angle- and cut-out cocks at the Chicago, Milwaukee, St. Paul & Pacific shops, Milwaukee, Wis., are shown in the illustration.

Defective angle cocks from outside car repair points are delivered to the air brake shop in skids. Each angle cock is then placed on the machine in the left foreground for the removal of the cap nut. This machine consists of a well-braced steel table on which is mounted a chuck, driven by an air motor with intermediate gears which reduce the speed so as to provide adequate power for removal of the nut. The angle cock is placed in a holding device and the cap nut inserted in the chuck which removes the nut easily. As shown in the illustration, a hinged sheet metal guard is provided to cover the speed-reducing gears while the machine operates.

After removal of the cap nut the angle cock is moved to the next machine which consists of a vertical air cylinder and piston equipped with a drift of the same size as the square portion of the angle-cock key. When air is applied to the cylinder the piston forces the drift against the key, thereby shearing off the holding pin. With the handle following the angle cock, the cock then is moved to the grinding machine in the center background of the illustration, where the key is ground to fit the angle cock body.

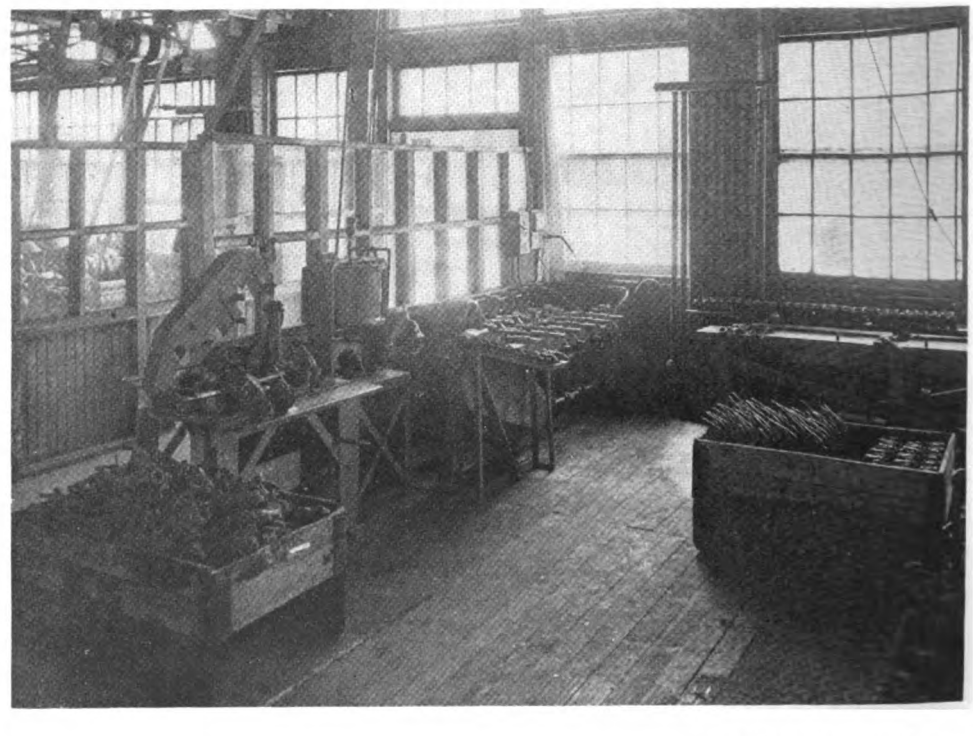
This machine is a six-spindle device which uses an oscillating movement to grind in the keys. The grinding compound employed in lapping each key to its seat is entirely soluble in water, which makes its removal in the cleaning operation a simple process. It is also superior to grinding compounds embodying an oil base as it is almost impossible to remove all traces of a compound of this nature and subsequently the compound which remains works itself between the key and its seat and soon causes leakage.

After the angle cocks are ground they are placed on trays and moved to the bench shown in the right background, at which three operators can be accommodated. The valves are then thoroughly washed out, lubricated and tested. The test consists of the application of air pressure at 100 lb. against the key with the angle cock body in a vertical position and the upper part filled with water. The body is then reversed and the other end tested. If there are any indications of bubbles the valves are sent back for regrinding.

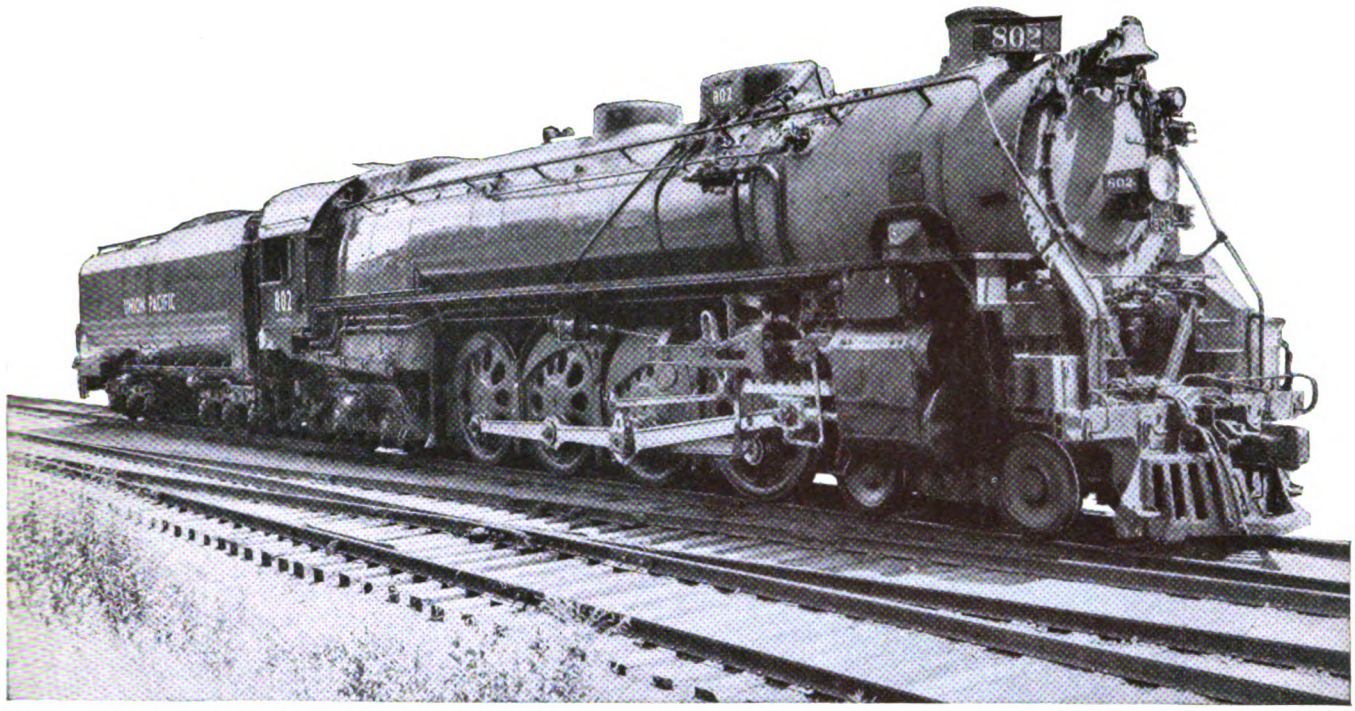
Repaired angle cocks are placed in another skid which, after being filled, is returned to the stores department for subsequent shipment to system repair points.

(*Turn to next left-hand page*)

* Air Brake Foreman, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.



One corner of the Milwaukee shop air brake room in which angle-cock repairs are handled on a quantity-production basis



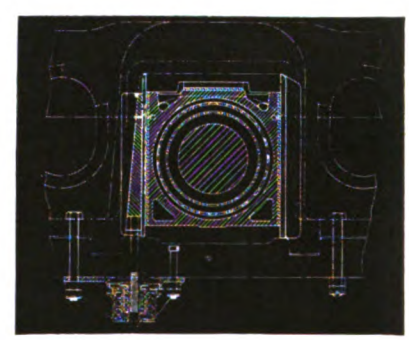
Photograph—courtesy Union Pacific R.R.

Outstanding Results with FRANKLIN AUTOMATIC COMPENSATOR AND SNUBBER on Union Pacific Locomotives

The Franklin Automatic Compensator and Snubber on 20 Union Pacific roller-bearing passenger locomotives has maintained a perfect fit between the driving boxes and the frames, automatically compensating for expansion and wear, and producing the following outstanding results:

1. Utilization — Monthly mileage 14,000 to 16,000.
2. Tire Mileage — Average 104,000 miles — Maximum 133,000.
3. Tire Condition — Uniformly round — No evidence of quarter slip.
4. Rod Bushings — Unusually long wear and minimum out-of-round.
5. No binders nor wheels dropped to adjust pedestal fits.
6. No work on Compensator and Snubber except periodic adjustment.
7. Compensators and Snubbers reapplied after tire turning with original parts — No repairs or replacements required.

It will pay you to investigate.



FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

High Spots in
Railway Affairs . . .

Shadow Boxing with the Railroad Problem

Based on statements of President Roosevelt prior to his first election in 1932, the railroads were led to believe that he would at least use his influence to see that they were given a square deal. Six years have now elapsed and their condition today is worse than ever before. His efforts in the meantime, so far as any concrete results are concerned, remind one of shadow boxing. His latest gesture has been to appoint a committee of six, consisting of three railway executives and three representatives of railroad labor, to consider the matter and report back to him in the near future with recommendations for legislation to be presented to Congress.

The committee consists of Carl R. Gray, vice-chairman, Union Pacific; M. W. Clement, president, Pennsylvania; E. E. Norris, president, Southern; George M. Harrison, chairman, Railway Labor Executives' Association; D. B. Robertson, president, Brotherhood of Locomotive Firemen and Enginemen; and B. M. Jewell, president, Railway Employees Department, American Federation of Labor. Apparently the committee struck a snag at the very outset, since according to a statement issued by Mr. Gray on behalf of the committee after meeting on September 21, the time of the labor executives will be so fully occupied during most of October that another meeting will not be held for some time.

The supposition, apparently, is that if the representatives of management and labor can agree upon a policy, and if it has the approval of the Administration, it will be promptly adopted by Congress. This, of course, overlooks the fact that the stockholders, the shippers and the public may have something to say about the enactment of railroad legislation. It seems strange, also, that railroad labor leaders are so little interested in safeguarding the interests of the carriers. It has been suggested that they are indifferent to the present situation in the belief that if the railroads can be forced into government ownership, labor will get more out of the government than it can out of the present managements.

Mediation Fails

All efforts of the National Mediation Board to compose the differences in the wage controversy between the railroad managements and the labor leaders having failed, President Roosevelt, on September 27, named a three-man fact-finding board, comprised of Professor H. A. Millis, recently-retired head of the Department of Economics of the University of Chicago, Dean James M. Landis of Harvard Law School, and Chief Justice Walter P. Stacy of the Supreme Court of North Carolina, which must report findings within 30 days. At the same time labor-union leaders have announced that a majority of their members have voted to strike. By reason of the appointment of the fact-finding board the effective date of the wage reduction is postponed for at least 60 days beyond October 1, the date originally set by the carriers, since the Railway Labor Act provides that the *status quo* be maintained until 30 days after the board reports back to the President. Apparently, in spite of the financial emergency the railroads are facing, the labor leaders are determined to string the case out to the bitter end. Obviously the situation is not having a helpful influence on general business or on railroad earnings.

Who Is At Fault?

A favorite sport of railroad labor leaders and demagogic politicians is to accuse the railroad managements of promoting unfair propaganda. The railroads have publicized the fact that the average 1937 wage of their employees was $1,785. The labor leaders have countered with the statement that this is a gross exaggeration and that the figure should be $1,115. Labor, their official organ, carried an eight-column heading which read: "Roads Greatly Exaggerate Workers' Pay, Pension Board Reports." As a matter of fact, the Railroad Retirement Board received a W. P. A. grant of $75,000 to do some research work. The study, which is still incomplete, shows that during the year 1937 there were 1,740,799 employees who received some pay from Class I railroads during that year. This number includes all the different names appearing on the payroll. For instance, 109,935 of these employees received less than $10 each for the year. Over 231,500 had work within only one month of the year, and 368,781 received less than $100 each for the year. It should be noted, also, that the Railroad Retirement Board is interested only in wages up to $300 a month and that the amount any individual earns in a month above this figure does not enter into the wages reported to it. Obviously any averages based upon such figures are misleading. The facts are that 84 per cent of the aggregate payroll used in this tabulation went to 917,900 employees, each of whom had some work in each of the 12 months. The railroad computation of the average annual earnings of $1,785 received by their workers is based upon the wages received by this latter group.

Railroad Transport Clinic

The railroads are ill—so much so, in fact, that the shippers and business interests that use their services are beginning to be seriously concerned about their condition. The United States Chamber of Commerce sponsored a Transportation Conference, which met in Washington on September 14 and 15 to discuss what can be done to formulate a suggested legislative program which can be presented at the next session of Congress. The seventy participants represented transportation, shippers and financial interests. Many suggestions were advanced by those present and by other individuals. The sessions of the conference were closed, but it is known that consideration was given to the program proposed by the Association of American Railroads. Before adjourning, the conference appointed a special committee of seventeen members, which will hold its first meeting in Washington on September 30; its duty will be to draft a comprehensive program to be presented at a later meeting of the conference, to be held at the call of the chairman. The committee is not in any sense a railroad or a railroad-controlled group, as may be noted by a glance at its membership, which follows:

Arthur M. Hill, chairman, president of the Atlantic Greyhound Corporation; C. J. Abbott, director of the American Livestock Association; Sidney Anderson, vice-president and secretary of General Mills, Inc.; Julius H. Barnes, president of the Erie & St. Lawrence Corporation; Samuel T. Bledsoe, president of the Atchison, Topeka & Santa Fe; Leslie Craven of the legal firm of Miller, Owen, Otis & Bailly, representing the American Bar Association; W. H. Day, chairman of the executive committee, National Industrial Traffic League; Charles Donley, president of the National Association of Advisory Boards; D. C. Fenner, vice-president of the Mack-International Truck Corporation; J. A. Gordon, president of the Transportation Association of America; J. M. Hood, president of the American Short Line Railroad Association; George H. Houston; F. N. Oliver, counsel for the National Association of Mutual Savings Banks; Carlton Putnam, president of the Chicago & Southern Air Lines; Ted V. Rogers, president of the American Trucking Associations, Inc.; Frank J. Taylor, president of the American Merchant Marine Institute, Inc.; and Harry A. Wheeler, president of the Railway Business Association.

(*Turn to next left-hand page*)



cut down on the arch and you boost the fuel bill

No one questions locomotive Arch economy. The Arch has been so thoroughly proved as a fuel saver by railroad after railroad for years past.

In the urge for money saving don't let the desire to save a few dollars in Arch brick expense by skimping on the Arch blind you to the fact that every dollar thus "saved", boosts the fuel bill ten dollars.

The surest way to the lowest operating cost is not in crippling proved economy devices but in making full use of them. This means complete Arches, with every brick in place, for each locomotive that leaves the roundhouse.

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists

Among the Clubs and Associations

CANADIAN RAILWAY CLUB.—At 8 p. m. on October 17 at the Windsor Hotel, Montreal, Que., L. K. Sillcox, first vice-president, New York Air Brake Company, will discuss "Crossing Paths in Transport."

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—T. P. Schmidt will lead in the discussion of Rule 4 at the meeting to be held on October 13 at the Burlington Station, Omaha, Neb.

NEW ENGLAND RAILROAD CLUB.—On October 11 Fairman R. Dick of New York City, a director of the Boston & Maine and of the Chicago, Milwaukee, St. Paul & Pacific, will present a paper on "The Modern Sisyphus." The meeting will start with dinner at 6:30 p. m.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The effect of "Locomotive Tonnage Ratings on the Economics of Railway Operations" will be the subject of a paper to be presented by J. E. Teal, transportation engineer, Chesapeake & Ohio, at the meeting to be held on November 17 at 10 a. m. at the Ansley Hotel, Atlanta, Ga.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—H. R. Rich, entomologist, Enoz Chemical Co., Chicago, will discuss Insect Control in Passenger and Freight Cars at the meeting to be held on October 18 at 8 p. m. at the Hotel Mayfair, St. Louis, Mo. Pictures, slides and hundreds of living insects in glass mounts will feature the discussion. Dinner will precede the meeting at 6:30 p. m.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION. — R. P. Ives, Westinghouse Air Brake Company, 3400 Empire State building, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION. — J. F. Gettrust, P. O. Box 5522, Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—C. E. Davies, 29 West Thirty-ninth street, New York. Annual meeting December 5-9. Engineering Societies building, New York.

RAILROAD DIVISION. — Marion B. Richardson, P. O. Box 205, Livingston, N. J.

MACHINE SHOP PRACTICE DIVISION.—J. R. Weaver, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

MATERIALS HANDLING DIVISION. — F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

OIL AND GAS POWER DIVISION. — M. J. Reed, 2 West Forty-fifth street, New York.

FUELS DIVISION. — A. R. Mumford, N. Y. Steam Corp., 130 E. Fifteenth st., New York.

ASSOCIATION OF AMERICAN RAILROADS. — J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

OPERATING SECTION. — J. C. Caviston, 30 Vesey street, New York.

MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

PURCHASES AND STORES DIVISION.—W. J. Farrell, 30 Vesey street, New York.

MOTOR TRANSPORT DIVISION. — George M. Campbell, Transportation Building, Washington, D. C.

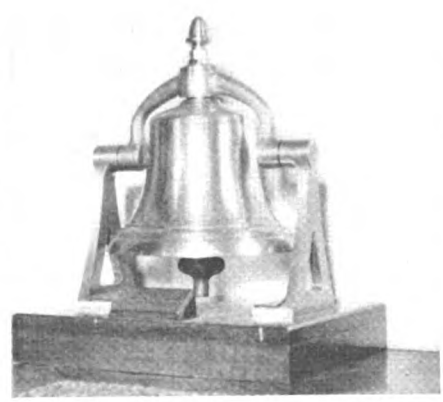
CANADIAN RAILWAY CLUB. — C. R. Crook, 4468 Oxford avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS. — J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, Hotel Mayfair, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

* * *



The bell from Baldwin Engine No. 5000 turned out in March, 1880

Built originally for the Philadelphia & Reading, the engine, a single driver type, was purchased in 1881 by Lovatt Eames and sent to England where it was used in demonstrating the Eames vacuum brake. In 1884 the locomotive was broken up for scrap, since which time the bell was used to summon engine terminal employees to work, most recently at the Hornsey locomotive terminal of the London & North Eastern. The bell is now in the possession of Richard E. Pennoyer, brother of A. Sheldon Pennoyer, an American artist noted for canvasses portraying railroad scenes

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p. m.

CENTRAL RAILWAY CLUB OF BUFFALO. — Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION. — E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, second Friday of each month, except May, June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION. — R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION. — See Railway Fuel and Traveling Engineers' Association.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—F. T. James (President), general foreman, D. L. & W., Kingsland, N. J.

INTERNATIONAL RAILWAY MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

MASTER BOILER MAKERS' ASSOCIATION. — A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB. — W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September, at Hotel Touraine, Boston.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July, August, September, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION. — E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, University and Prior avenue, St. Paul.

PACIFIC RAILWAY CLUB. — William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Calif., alternately, excepting June in Los Angeles and October in Sacramento.

RAILWAY CLUB OF GREENVILLE. — J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FIRE PROTECTION ASSOCIATION.—P. A. Bissell, 40 Broad street, Boston, Mass.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION. — T. Duff Smith, 1255 Old Colony building, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION. —J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

TRAVELING ENGINEERS' ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

WESTERN RAILWAY CLUB.—W. L. Fox, executive secretary, Room 822, 310 South Michigan building, Chicago. Regular meetings, third Monday in each month, except June, July, Aug. and Sept.

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IT'S HERE!

VITALIZED AIR CONDITIONING

FOR RAILWAY PASSENGER CARS

Sturtevant
Puts Air to Work

Investigate this important step forward in Railway Air Conditioning. Our nearest office will gladly supply complete information.



Adds to the pleasure and healthfulness of railway travel . . . . makes possible worthwhile economies

CONDITIONING OF AIR for passenger cars so that it will have a pleasing, mellow quality . . . rather than a sharp, shocking coldness . . . has always been the goal in railway air conditioning. With the introduction of Sturtevant "Railvane" Spray Type Washers an important step forward in this direction was made.

Now, with the development of the new Sturtevant *Wet-Bulb* Thermostat auxiliary control, still another important advance has been made. Sturtevant *Automatic* VITALIZED Air Conditioning is here!

In a nutshell, Sturtevant Vitalized Air Conditioning provides conditioned air containing certain vital and comfort qualities usually associated with air from the outdoors. It makes possible the circulation—automatically—of 100% outdoor air under auxiliary wet bulb temperature control, without overloading existing mechanical refrigeration apparatus. It also makes possible worthwhile economies in operation and maintenance.

It means:

1. Air washed with cleansing water sprays . . . removing dust and dirt.

2. Air mellowed to a more uniform temperature and humidity—to avoid shock to passengers.

3. Reduction in odors usually associated with "stale" cars.

4. Evaporative Cooling - and material economies in ice consumption, on cars equipped with ice water cooling systems.

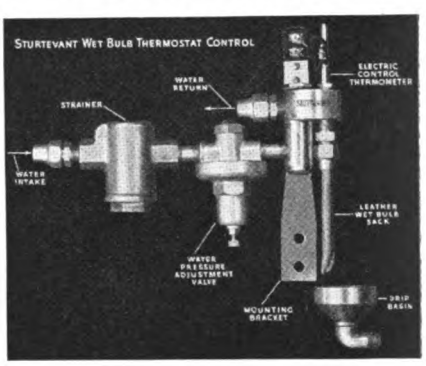
5. Less frequent starts and stops of existing mechanical refrigeration equipment, with probable reduction in maintenance expense.

6. Air Sterilization—either by the action of the water sprays or by the use of ultra-violet rays when the water sprays are not in operation.

Sturtevant RAIL VANE TRADE MARK UNITS OR SYSTEMS

Sturtevant "Railvane" Units or Systems are used by 37 railroads. "Railvane" Air Conditioning is protected by 30 issued patents and other patents pending.

THE KEY TO VITALIZED AIR CONDITIONING



One of the most important Railway Air Conditioning developments of the Sturtevant Research Laboratories—a positive, accurate, rugged Wet-Bulb Thermostat for regulating fresh-air. It is located in the outside air-intake opening of the passenger car.

This thermostat control permits circulation of 100% outside air when weather permits—automatically—and without overloading existing mechanical refrigeration apparatus.

1. By providing satisfactory regulation of evaporative cooling, it makes possible economies in ice consumption on cars equipped with ice-chilled water spray type air conditioning systems.

2. It reduces maintenance of existing mechanical refrigeration apparatus by reducing the number of starts and stops of this equipment.

This new Wet-Bulb Thermostat has been in operation on conditioned passenger cars through an entire summer season and has given utmost satisfaction.

B. F. STURTEVANT COMPANY
HYDE PARK, BOSTON, MASS., *Branches in 40 Cities*
B. F. Sturtevant Company of Canada, Ltd.
Galt, Toronto, Montreal

FOR 27 YEARS . . . PIONEERS IN AIR CONDITIONING

NEWS

C. & I. M. Contracts Rebuilding Job

THE Chicago & Illinois Midland has entered into a contract with the Pullman Standard Car Manufacturing Company for the rebuilding of 100 seventy-ton gondolas.

Gisholt Entertains Employees

OVER 2,000 persons, employees and their families, visited the plant of the Gisholt Machine Company at Madison, Wis., on August 27, when they were given an opportunity to become better acquainted and more familiar with the various activities of the company through personal inspection. Officers of the company were on hand to greet the visitors. A light repast was served following the inspection.

S. A. L. Premier Winter Train To Be Diesel Hauled

DIESEL electric power is to haul the Seaboard Air Line's "Orange Blossom Special" on its initial trip this December by reason of scheduled delivery of nine new Diesel electric locomotive units ordered recently by the road. An additional new feature of the new service will be the change of the Seaboard Air Line's northern operating terminus from Richmond, Va., to Washington, D. C., and the operation of the new locomotives through to the Capitol City.

It is expected that the locomotive units will be operated chiefly in groups of three, each group having control cabs on both ends. "A" units carry the cabs, while "B" units are fitted for service between "A" units. Each "A" unit, however, is in reality a 1,800-hp. locomotive and can be operated separately. Likewise, each "B" locomotive can be coupled to a single "A" unit and the extra three "A" units used separately. Each locomotive carries two 900-hp., 12-cylinder, V-type, two-cycle General Motors Diesel engines.

Unishear Contest

THE Stanley Electric Tool Division, The Stanley Works, New Britain, Conn., will conduct, from September 15 until October 31, a contest to find out who owns the oldest "Mighty Midget" unishear still in use. To compete in the contest, for the winner of which there will be a new Mighty Midget, firms are requested to send to Stanley the serial number of their unishears and to describe briefly for what type of work it is used. The name "Stanley" is not expected to appear on the oldest shear in use, as the Mighty Midget was not added to the Stanley line until 1929. Previous to that time the shears were manufactured by the Unishear Company, New York.

New Construction

The Great Northern is planning the installation of a direct steaming system for 20 stalls in its enginehouse at the Hillyard shops, Hillyard, Wash.

The Seaboard Air Line is building two oil fueling stations at Hamlet, N. C., and Wildwood, Fla., respectively, for the purpose of serving nine new Diesel-electric units recently ordered.

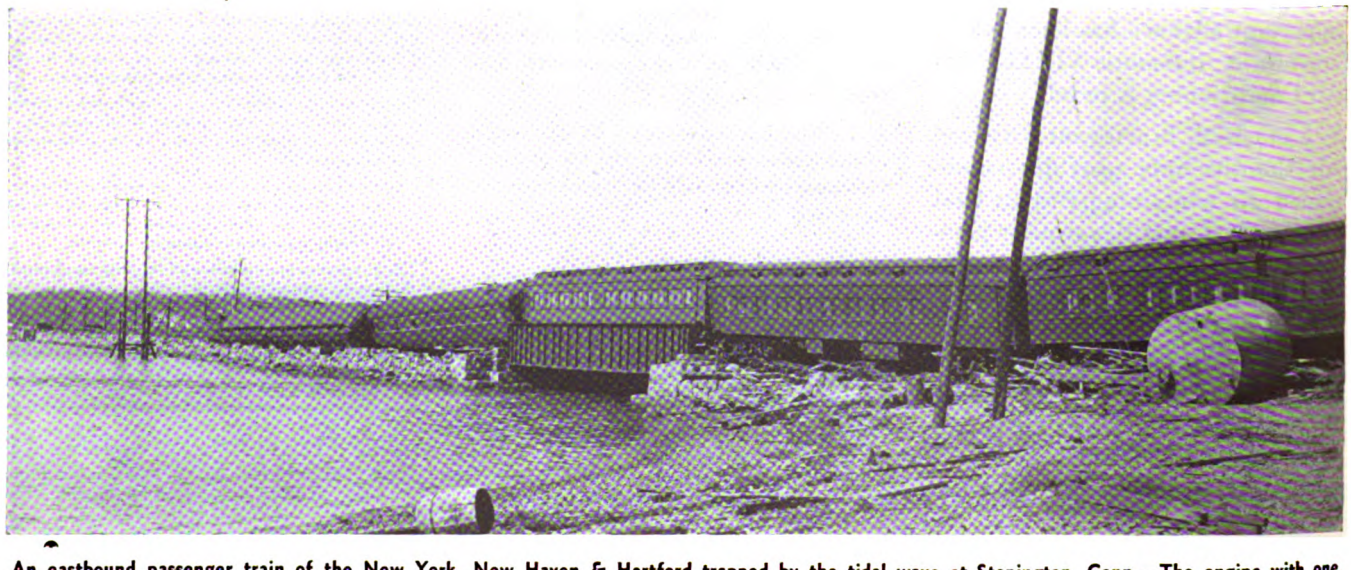
The Atchison, Topeka & Santa Fe, in connection with extensive improvements in its passenger engine and coach terminal at Chicago, has awarded a contract to Holton, Seelye & Company, Chicago, for the erection of a shop building of steel and concrete construction for making repairs to Diesel engines. This building, which will be 112 ft. by 324 ft., with an annex 53 ft. by 202 ft., will cost approximately $250,000, and will be equipped to overhaul and clean a complete streamline train in eight hours.

American Refrigerator Transit Co., which is jointly owned by the Missouri Pacific and the Wabash, in connecion with extensive improvements to its car shops in St. Louis, Mo., has awarded a contract to the Woermann Construction Company, St. Louis, for the erection of a one-story brick office, wash and locker building, 38 ft. by 60 ft.; a car repair shed, 92 ft. by 430 ft.; a mill shop, 59 ft. by 186 ft.; a compressor building, 26 ft. by 55 ft.; a welding shop, 25 ft. by 55 ft.; a paint storage building, 25 ft. by 125 ft.; and the relocation on a new concrete foundation of an existing 15-ft. by 40-ft. waste renovating building. All of the new structures, except the office building, will be of structural steel frame construction with corrugated asbestos roofing and siding. The total cost of the new shop building and the machinery for these improvements will be between $200,000 and $300,000.

Stoker Order Again Postponed

THE Interstate Commerce Commission has postponed from October 1 to November 15 the effective date of its order in the automatic stoker case. The action came "upon further consideration of the record . . . and to comply with the terms of the stipulation heretofore entered into by all parties to the court proceeding relating to the order . . . now pending in the United States District Court for the Northern District of Ohio, and to afford opportunity for proper consideration of said case by the court." For similar reasons the effective date of the order was

* * *



An eastbound passenger train of the New York, New Haven & Hartford trapped by the tidal wave at Stonington, Conn.—The engine with one car escaped to higher ground

previously postponed from July 1 to October 1.

The commission's report in this case (No. 24049, A. Johnston, Grand Chief Engineer of the Brotherhood of Locomotive Engineers, et al. v. The Atchison, Topeka & Santa Fe Railway Company, et al.) was reviewed in the February issue of the *Railway Mechanical Engineer*, page 80.

Railroad Men Get Awards in Welding Paper Competition

THE jury of awards of the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, announced on September 15 that J. H. Hruska, metallurgical engineer, Electro-Motive Company, La Grange, Ill., received the highest award in the railroad classification, the amount of $2,543.88, for his paper entitled "Welded Body of Diesel Locomotive." C. B. Faverty, chief engineer, Ryan Car Company, Chicago, received $1,526.33 for his paper "Arc Welded Underframe for Freight or Passenger Car." R. H. Redline, welding supervisor, American Locomotive Company, Dunkirk, N. Y., received $1,322.82 for "Welded Locomotive Boiler."

Of the other awards in the railroad classification, $712.28 went to W. C. Rockenstire, assistant superintendent, American Locomotive Company, Schenectady, N. Y.; $508.77 jointly to E. A. Brooker, metallurgist, Bureau Construction and Repair, U. S. Navy, and F. A. Boyer, inspector, Atchison, Topeka & Santa Fe, Topeka, Kansas, co-authors; and $508.77 to H. C. Ventner, superintendent, Sacramento general shops, Southern Pacific, Sacramento, Cal. An award of $305.26 went to M. A. Burke, general foreman, locomotive tender shop, Lima Locomotive Corp., Lima, Ohio. G. S. Edmonds, superintendent of motive power, Delaware & Hudson, Albany, N. Y., and W. Simons, superintendent of shops, Cliffs Dow Chemical Company, Marquette, Mich., each received $203.51.

Awards of $152.63 were received by J. E. Muhlfeld, consulting engineer, Kansas City Southern, and R. S. Twogood, assistant engineer, Southern Pacific.

Bureau of Service Director Dies in Washington

HARVEY BOLTWOOD, who had been serving as director of the Interstate Commerce Commission's Bureau of Service since March, 1937, died while en route to his office at the commission on September 2.

New Equipment Orders and Inquiries Announced Since the Closing of the September Issue

LOCOMOTIVE ORDERS

Company	No. of Locos.	Type of Loco.	Builder
Texas-Mexican	7*	Diesel-elec.	Baldwin Loco. Wks.
Wheeling & Lake Erie	5	2-8-4	American Loco. Co.

LOCOMOTIVE INQUIRIES

New York Central	...	Diesel-elec. switch†	.....

FREIGHT CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Bessemer & Lake Erie	100‡	50-ton, all-welded box	Pullman-Standard
Chief of Engineers, United States Army	25	10,000-gal. tank	American Car & Fdry. Co.
J. M. Huber Corp.	4	40-ton hopper	American Car & Fdry. Co.
Illinois Central	1,000§	40-ton box	American Car & Fdry. Co.
Union Pacific	50‡	Box	Pullman-Standard

PASSENGER CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Alabama Great Southern	2 trains ø	.....	St. Louis Car Co.
Southern	4 trains ø	.....	St. Louis Car Co.
Chicago, Burlington & Quincy	1 train **	.....	Edw. G. Budd Mfg. Co.
	2 sleeping **	.....	

* The Texas-Mexican has applied to the Interstate Commerce Commission for approval of a plan to issue $200,000 of equipment trust certificates to the Reconstruction Finance Corporation to finance, in part, the purchase of these locomotives.

† Each of 600 hp. The New York Central's plan for securing a $5,000,000 work loan has been approved by the Interstate Commerce Commission. The company has returned 3,804 men to work in its various shops.

‡ Leased, with option to buy.

§ With steel sheathing and wood lining. To cost approximately $2,700,000. For early 1939 delivery.

ø The Southern has ordered, subject to the approval of the Interstate Commerce Commission, four Diesel-electric passenger trains, consisting of two units each, consisting of an 80-ft. steel Diesel-electric combined mail, baggage and power car and a 63-ft. 10-in. steel air conditioned passenger coach. The trains will be built by the St. Louis Car Company, and the engines supplying the power will be constructed by Fairbanks, Morse & Co. The specifications for the Alabama Great Southern trains are identical.

** The train, another Zephyr of 4 cars is to be equipped with a 1,000-hp. Electro-Motive Corp. Diesel engine for generating electric power. The sleeping cars are for use in the Denver Zephyrs.

Mr. Boltwood took the position vacated by W. P. Bartel when the latter was appointed to the office of secretary.

Mr. Boltwood was born in Albany, N. Y., July 6, 1875, and was educated in the public schools there and in Denver, Colo. He attended Colorado College and continued his studies by correspondence. He began his railroad career with the Union Pacific in 1896 as night engine wiper and call boy, and, continuing in mechanical department work on several railroads, filled various positions up to master mechanic. This railroad service was with the Union Pacific, Denver & Gulf, the Colorado & Southern, the Denver & Rio Grande, and the Union Pacific in Colorado and New Mexico. Also, he was for a period connected with the gold mining and milling industry in Colorado, Idaho and Washington.

When the Bureau of Locomotive Boiler Inspection of the Interstate Commerce Commission was organized in 1911 Mr. Boltwood was one of the original 50 district inspectors. He remained with that organization until 1918 when he was transferred to the United States Railroad Administration, Division of Operation, as supervisor of equipment. When the railroads were returned to private operation he was appointed mechanical engineer with the Mechanical Department, Division of Liquidation Claims of the Railroad Administration. In 1923 he returned to the Bureau of Locomotive Inspection, I. C. C., and in April, 1925, was appointed assistant director, Bureau of Service.



H. Boltwood

Supply Trade Notes

JOHN S. LEMLEY, 1641 Railway Exchange building, St. Louis, Mo., has been appointed representative of the Graham-White Sander Corporation, for the St. Louis and Southwestern region.

◆

THE WARNER & SWASEY Co., Cleveland, Ohio, completed its fifty-thousandth turret lathe on September 28. In celebration of the event a special program of plant inspection, lunch and dinner were arranged for guests in attendance.

◆

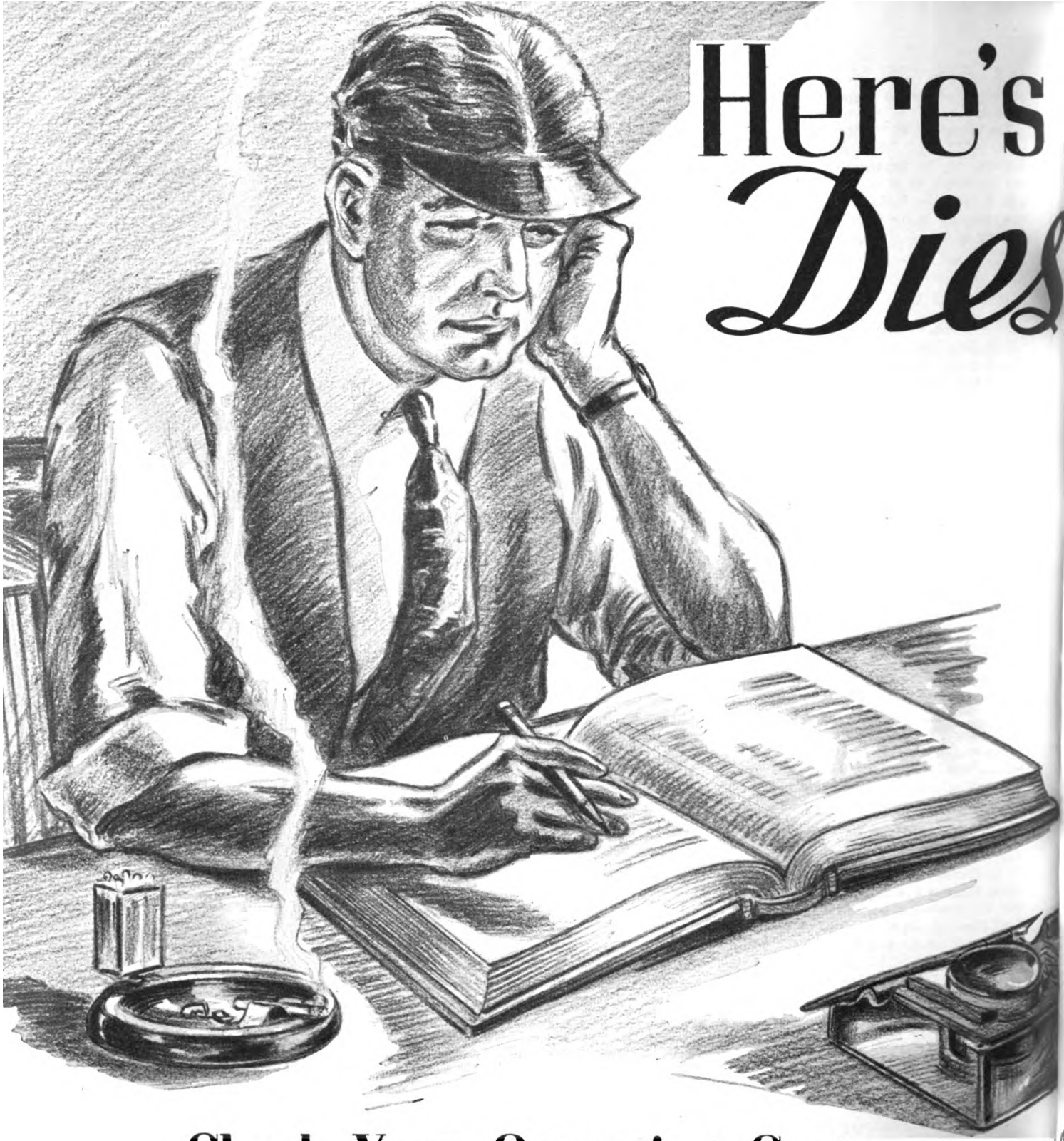
ROY H. SJOBERG has been appointed sales representative in the New York district of the J. G. Brill Company reporting to L. H. Corlette, district sales manager, 30 Church street, New York.

AVERY PHILLIS has been appointed district manager of the mid-western sales territory of Beaver Pipe Tools, Inc., with headquarters at Chicago.

◆

CURTIS G. GREEN, formerly district manager for the Baldwin Locomotive Works at St. Louis, Mo., has been transferred to

(*Turn to second left hand page*)



Check Your Operating Costs

A comparison of costs reveals that non-Diesel users are paying a terrific premium for switching service. They are carrying a 400 per cent extra burden in hourly fuel costs — 200 per cent higher roundhouse costs — 100 per cent extra for maintenance.

ELECTRO-MOTIVE

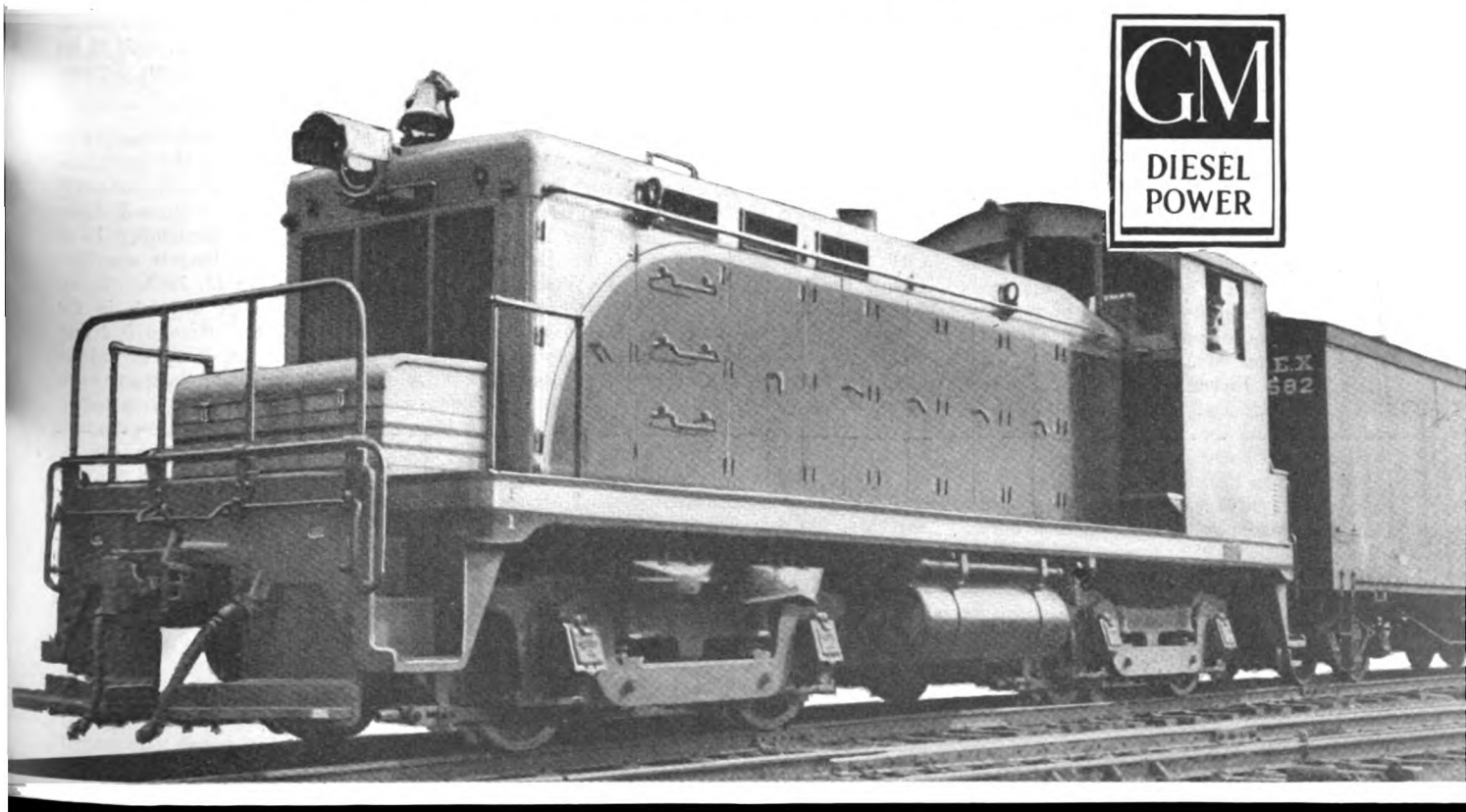
SUBSIDIARY OF GENERAL MOTORS

Your Answer....

el Operation

IF operating costs are out of line, surely a 50 per cent reduction in such a magnitudinous expense as yard switching should interest you. This service cost the Class I railroads $328,000,000 in 1936. The major items included $35,403,983 for coal (exclusive of transportation costs); $39,676,146 for repairs; $16,539,115 for roundhouse expenses and $3,326,531 for water.

Actual records show that EMC Diesel operation reduces fuel costs by 80 per cent, maintenance by 50 per cent, engine-house expenses by 66 per cent and water costs are eliminated entirely.



CORPORATION

LA GRANGE, ILLINOIS, U. S. A.

the Chicago office as assistant district manager. A. B. McCoy, who had been Mr. Green's assistant, has been appointed district manager at St. Louis. Henry K. Patjens has been transferred from Chicago to the St. Louis office as assistant to Mr. McCoy.

◆

ABBOTT F. RIEHLE, formerly in charge of sales and management of the Riehle Bros. Testing Machine Co., has been appointed sales manager of the Smootharc welder and welding electrode divisions of Harnishfeger Corporation, Milwaukee, Wis.

◆

GEORGE HARRISON HOUSTON, president of the Baldwin Locomotive Works since 1929, has resigned, and Charles E. Brinley, a member of the board and of the executive committee of the company, has been appointed acting vice-president with executive powers. Mr. Brinley will continue also as president of the American Pulley Company. Mr. Houston served as president of the Baldwin Locomotive Works since March 28, 1929, when he succeeded Samuel M. Vauclain. Before his election as president of Baldwin, he spent most of



G. H. Houston

his business career as an industrial engineer. He was born at Covington, Ky., on January 4, 1883, and received his early education in the public schools of that city and at the Cincinnati (Ohio) Technical School. Later Mr. Houston became associated with Fisher Brothers of Detroit, Mich., as technical adviser, upon their establishment of the Fisher Body Company, and was affiliated with them until 1929. From 1916 to 1920 he was a member of the engineering firm of George W. Goethals Company and headed his own firm during the years 1921-1922, during which period he was concerned with the reorganization and management of several industrial concerns, including the Wright-Martin Aircraft Company and the Wright Aeronautical Corporation. Mr. Houston is president and director of several Baldwin subsidiary companies. In 1934, during the period of the National Recovery Administration, he was appointed by Administrator Hugh Johnson as chairman of a committee representing the capital goods industry.

◆

ARTHUR JAMES MANSON has been appointed transportation sales manager of the Westinghouse Electric & Manufacturing Co., with headquarters at Pittsburgh,



Arthur James Manson

Pa., following the recent consolidation of the transportation and generator divisions of the company. Mr. Manson was born at Scituate, Mass., and was educated in the Boston public schools and was graduated as an electrical engineer from Massachusetts Institute of Technology in 1905. The same year he entered the student's course at Westinghouse. His engineering assignments included the electrification of the Pennsylvania Railroad tunnel in New York City and the electrification of the Long Island Railroad, the Norfolk & Western and other lines. In 1912 Mr. Manson became a special railway salesman for Westinghouse in New York and eight years later was appointed manager of the transportation division. In 1924 he was appointed manager of the heavy traction section at East Pittsburgh, Pa., and in 1931 he became assistant sales manager of the transportation department. Last November, Mr. Manson was appointed manager of the transportation division.

THE CARBOLOY COMPANY, INC., Detroit, Mich., will resume this fall the Carboloy "schools" it has conducted during the past year to acquaint shop men with all practical phases in the use of cemented carbides. The course, conducted either in local Carboloy offices or in the users' plants, is available without charge to executives and shop men engaged in the metal-working industries. Arrangements to attend can be made through the Detroit office of the company or through any Carboloy representative.

◆

J. C. BARNABY, manager of the Worthington Pump & Machinery Corporation's Oil and Gas Engine Application division, at Buffalo, N. Y., and responsible for engine sales in the Central division, has been placed in charge of special engineering work covering engine research and design. W. E. Wechter, in charge at New York of engine sales in the Atlantic division, has been transferred to Buffalo to succeed Mr. Barnaby, and he will be assisted by J. F. Hecking, assistant manager of the Oil and Gas Engine Application division. The Atlantic division, oil engine sales will be covered by H. C. Wood at New York, while W. L. Russell, at Harrison, N. J., will take over the gas engine sales, in addition to Mr. Russell's present responsibilities as Manager of the Eastern division of Worthington Oil and Gas Power Sales.

Obituary

ROBERT B. BEALE, manager of turbine sales in the central station department of the General Electric Company, died at his home in Schenectady, N. Y., on September 11.

GEORGE D. BASSETT, retired manager of the railroad department of the H. Channon Company, Chicago, and formerly vice-president of Crerar, Adams & Company, Chicago, died on September 10 at West Chicago, Ill. Mr. Bassett was born in Batavia, Ill., on May 17, 1863. He entered railway service as a clerk in the store department of the Chicago & North Western, and on June 16, 1879, entered the employ of Crerar, Adams & Company as an office boy. In 1898 he was promoted to salesman, and in 1924 to vice-president. On July 1, 1931, he went with the H. Channon Company as manager of the railroad department and served in that capacity until his retirement on February 15, 1935.

Personal Mention

General

F. A. BUTLER, superintendent motive power and rolling stock of the Boston & Albany, with headquarters at Boston, Mass., retired on September 30.

C. S. PERRY, master mechanic of the Atlantic, Birmingham & Coast at Fitzgerald, Ga., has been appointed superintendent of motive power, with headquarters at Atlanta, Ga.

CHARLES J. GRAHAM, vice-president of the Pressed Steel Car Company, has been elected president of the Pittsburgh & West Virginia, with headquarters at Pittsburgh, Pa., to fill the vacancy caused by the death last June of Frank E. Taplin, of Cleveland. Mr. Graham was born on March 13, 1878, at Pittsburgh, and entered the bolt and nut business on January 6, 1896, with John Charles & Co. When the latter company became the Graham Nut Company, Mr. Graham became a partner, and when it was incorporated in 1904, he became vice-president. Mr. Graham retained the vice-presidency in 1922

RAILWAY MECHANICAL ENGINEER

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With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.

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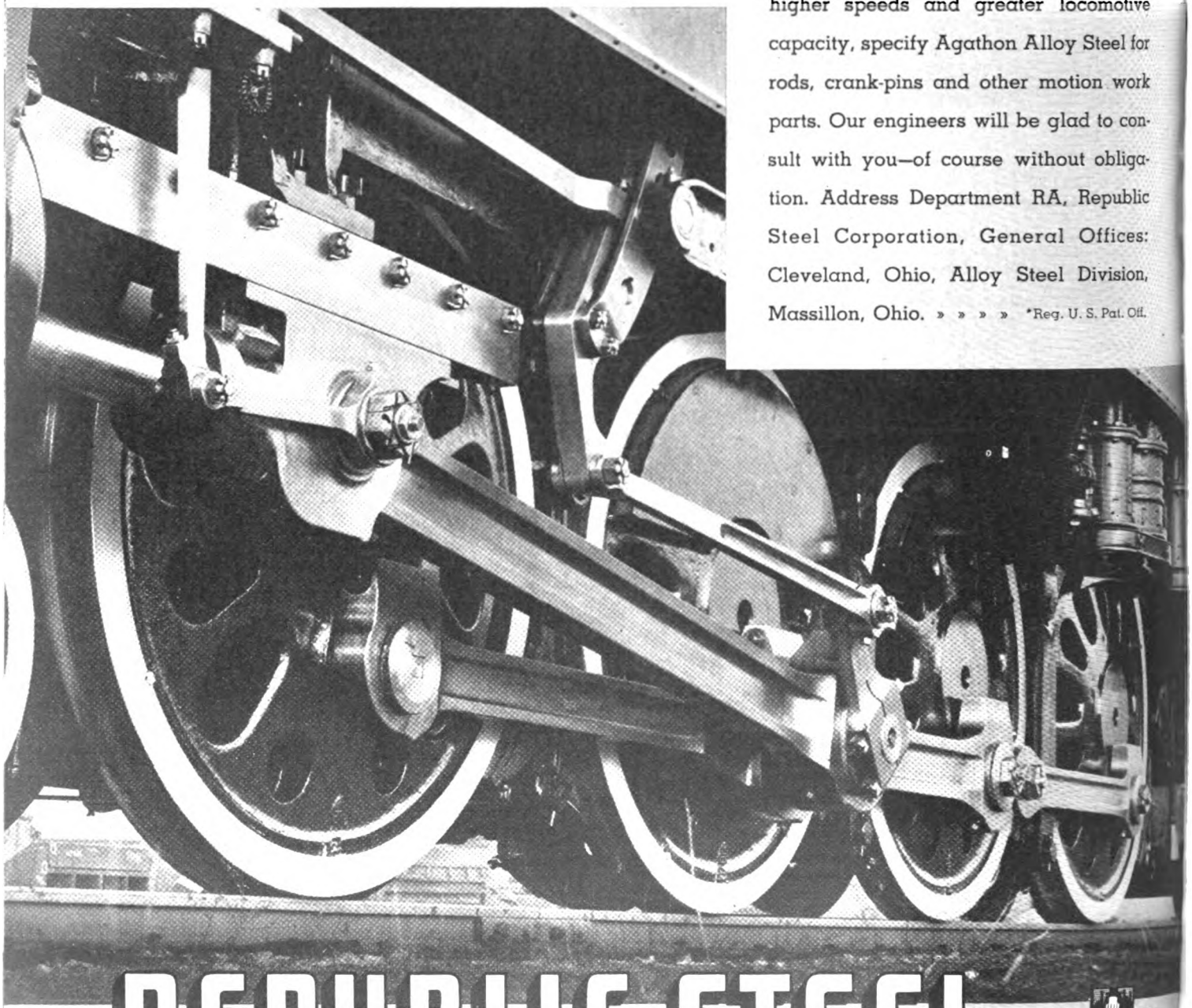
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Full Program of Reports Presented at Business Meeting of the Master

Boiler Makers' Association



Carl Harper,
Vice-President



W. N. Moore, President



A. F. Stiglmeier,
Secretary-Treasurer

THE twenty-fifth annual meeting of the Master Boiler Makers' Association was held at the Hotel Sherman, Chicago, September 26 and 27, the first day being devoted to an executive committee meeting, while the second was devoted to the presentation of seven topics, abstracts of which are herein included. Although the meeting was called for committee members only, 56 railroad members and guests were registered at the Tuesday session.

A committee report was presented on topics selected for the 1939 meeting, a change in the scope of which is intended to increase the service rendered by the association to the railroads. Among the new topics selected for presentation at the 1939 meeting will include (1) recommended practices to railroad management on the training of boiler-maker apprentices, (2) the standardization of inspection, testing and cleaning of air reservoirs, (3) the renewal of fireboxes, including laying out, fabrication and application, as well as the application of crown and staybolts, (4) a standard practice for locating the height of crown sheet, water glass, gage cocks and low-water-alarm drop pipe, and also recommended practices for marking the back head for water level and the highest point of the crown sheet, (5) the advantages and disadvantages of using all-welded and alloy steel for locomotive cisterns to decrease weight and to reduce pitting and corrosion, and (6) the causes of flues in service cracking longitudinally through the bead and means for eliminating such cracking.

Improving boiler circulation, honeycombing and slagging, proper waste-bear designs, pitting and corrosion, cinder cutting, and the proper method of applying flexible staybolts are among the subjects discussed

Because this year's session constituted a business meeting only, it was decided that the officers elected in 1937 should direct the association's activities during the coming year. These are as follows: President, W. N. Moore, general boiler foreman, Pere Marquette, Grand Rapids, Mich.; vice-president and chairman of the executive board, Carl Harper, general boiler inspector, Cleveland, C. C. & St. L., Indianapolis, Ind.; secretary-treasurer, A. F. Stiglmeier, general foreman boiler department, New York Central, West Albany, N. Y. M. C. France, general boiler inspector, C. St. P. M. & O., St. Paul, Minn.; L. W. Steeves, boiler foreman, C. & E. I., Danville, Ill.; and C. W. Buffington, master boiler maker, C. & O., Huntington, W. Va., were elected in 1937 to three-year terms on the executive board and

L. R. Haase, district boiler inspector, B. & O., Swissvale, Pa., will continue to serve out the unexpired term on the executive board of W. N. Moore, who was elected president of the association.

Secretary Stiglmeier, reporting on the financial status of the association, announced that the executive committee had decided that membership dues would be waived for the year 1939-1940.

Suggestions for Reducing Leaky Stays and Cracked Side Sheets

Improved boiler circulation, proper washing of boilers, water treatment, and standard methods of changing water aid in boiler maintenance

Chairman C. W. Buffington (C. & O.) reported on Topic No. 1: "What means can or have been suggested to improve circulatory and other conditions in the locomotive boiler to eliminate leaky stays and cracked side sheets?" He stated that standard practice for boiler washing, blowing down of boilers, filling up of boilers and firing up, together with the treatment of boiler feedwater, have aided materially in great improvements during the past 13 years in reducing the number of leaky staybolts and cracked side sheets on the C. & O. The chairman presented each of his committee members in turn, who read individual reports as follow:

Report by D. A. Stark

The following have resulted in improved boiler conditions on the Lehigh Valley: (1) The careful washing of boilers, (2) the careful blowing down and filling up of boilers and (3) the use of treated feedwater. Prior to the use of the latter, it was necessary on the Lehigh Valley to renew side sheet on an average of 15 to 18 months, while at the present time we are averaging 6 years. There have been also experiments of different methods of application of staybolts which, by increasing the water space and increasing the width of the mud ring, have resulted in better circulation; I believe is a big factor in the solution of this trouble.

Report by J. F. Powers

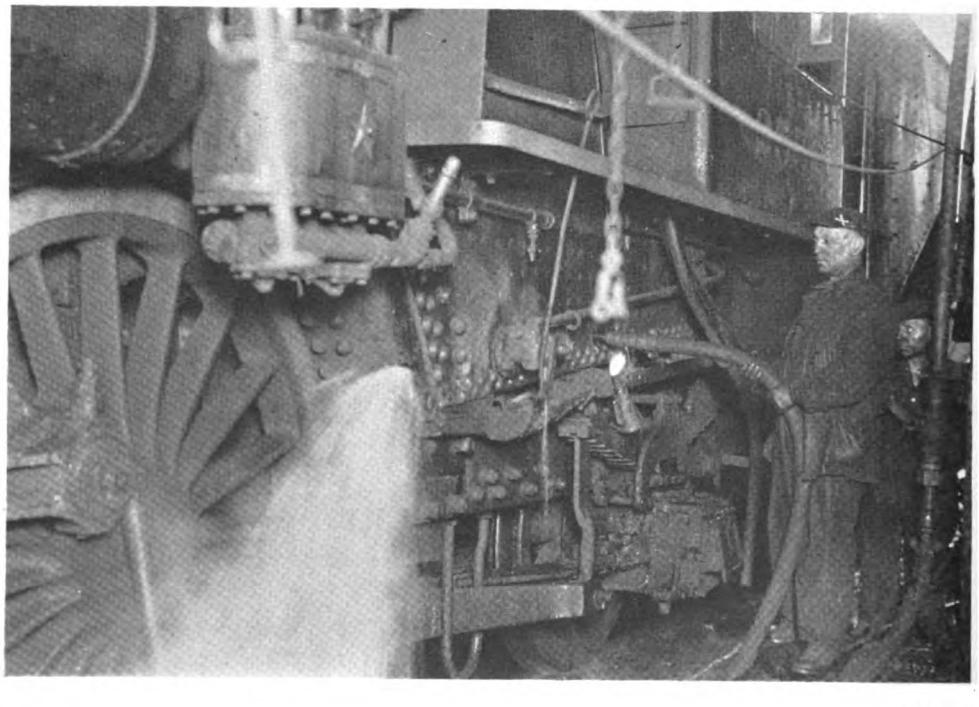
The Master Boiler Makers' Association's report for 1935 included a number of special papers, among which was Topic No. 3 entitled: "Staybolt Leakage and Cracking of Firebox Sheets—What Can Be Done to Prevent Same?" This included a complete report on the design of standard side sheets with corrugations. This design of side sheet has been used for the past 30 years by the Chicago & North Western, and with them we have experienced very little trouble with leaky staybolts.

It is generally accepted that adding heating surface and circulation to the conventional type of locomotive firebox and combustion chamber increases the efficiency of the locomotive; therefore, any type of circulator which is properly designed and can be maintained without interrupting the availability of the locomotive and with reasonable amount of expense is an asset to the locomotive.

Well-designed circulating devices are becoming an important factor, if not a necessity, due to the increasing horsepower of the modern steam locomotive and capacity from the boiler. Adding properly designed circulators to the firebox and combustion chamber in the opinion of the committee relieves the balance of the firebox of some of the work it would otherwise be required to do, particularly the side sheets where the temperature is high under the brick arch; this should help to eliminate leaky staybolts and prolong the life of the side sheets.

Report by W. R. Hedeman

Various means have been suggested for improving boiler-water circulation and a few have been tried out in service. One of the earliest means of major impor-



tance was the arch tube, though their application was primarily made for supporting the arch brick. However, these tubes do provide a definite circulation from the throat sheet to the upper portion of the back head. This has been conclusively proven by tests, showing that in arch tube locomotives the water surges higher at the back head than the normal water level, this surging being due to the rapid movement of the water through the arch tubes.

Various other methods have been tried out, some of which are still in use, one being the semi-water-tube firebox, having water troughs in the crown sheet connected to the side water legs by means of circulating tubes. This design has the effect of providing rapid circulation of the water from the bottom of the side water leg up along the side sheets to the tubes, and through them to the troughs, thence to the steam disengaging surface. Another type of circulator is the syphon, a great many of which are in service, and still another is the design of circulators consisting of several vertical water legs dropped from the crown sheet with transverse connections to each side water leg.

Since this subject deals principally with prevention of leaky staybolts and cracked side sheets, a design of firebox not possessing either one of these features, that is the staybolts or side sheets, would eliminate this trouble, and there are a number of such fireboxes in practical and successful service today.

We have on the Baltimore & Ohio, 12 locomotives with water-tube firebox boilers, the first built in 1927 and the last a four-cylinder type built in 1937, the total mileage to date of these locomotives being nearly 4,000,000 miles.

This design consists of a horizontal longitudinal drum at the top of the firebox, having rectangular shaped side headers connected thereto by means of 4-in. diameter nipples. These top headers in turn are connected to longitudinal lower side headers, flush with the grate surface, by means of double and triple rows of vertical water tubes which comprise the sides of the firebox, so far as the heating surface is concerned. These tubes are practically vertical and it is generally recognized that a tube of this type provides the best means of circulation.

Aside from the elimination of troublesome maintenance problems, improved circulation is highly desirable as a means of providing more efficient and economical production of steam.

All the water should circulate in one continuous current in a constant direction in order to carry off the steam quickly and to insure that the generating tubes contain as little steam and as much water as possible, which is essential to evaporative economy. The generating tubes should be arranged to facilitate free escape of the steam. When steam is generated in tubes, the steam bubbles rise most freely when the tubes are vertical and least freely when they are horizontal.

It has long been recognized that improved circulation is the purpose of water-tube boilers and experiments have demonstrated that the nearer vertical and straight the tubes stood in the boiler the more perfect the circulation, the freer it is from scale and steam pockets.

Report by C. A. Seley

The fundamental cause of leaking staybolts, cracked side sheets, and pitting and corrosion is mainly due to temperature differences in the various parts of the boiler, wherein the fire is at the back end and the feedwater is introduced at or near the front end; with a common temperature of the upper portion of the whole length of the steam space.

The obvious remedy for these troubles is to reduce the temperature range in the water leg by (1) preheating to the highest possible degree before admission to the boiler, and (2) promoting circulation of the introduced feedwater, which, due to its gravity, quickly seeks the lower portion of the boiler shell.

Remedy No. 1, preheating before admission cannot be done on a locomotive with any great degree of uniformity or in amount of heat transfer, as is possible in much of stationary power practice, due to the varying service of the locomotive, and use of the exhaust in the draft promotion.

The boiler water, therefore, is quite generally introduced into the boiler at temperatures around 200 deg., more or less, lower than the steam temperature. If considerably jetted it may pick up considerable heat in seeking the shell bottom and in its backward travel to the lower temperature level in the firebox throat and sides.

The general water circulation, due to the accretion of heat and the transfer into steam, draws the water from these lower regions, forces it upward at the side sheets and then forward over the crown sheet toward the flues, thereby maintaining the proper water level throughout the boiler. Thus, the bare locomotive boiler, regardless of size, provides for some self-generated circulation.

In order to increase that circulation, it would be necessary to introduce a device embodying a connection to the lower part of the boiler and extend it into the firebox, thereby creating additional heating surface and steam production, discharging into the upper region around or over the firebox, thereby greatly increasing the general circulation and minimizing the range of water temperature within the boiler.

With the growth in size of fireboxes came the necessity for directing hot gases to fill and heat the upper back corners, which brought about the use of arches and arch tubes. The latter, while primarily used as a support of the arch, incidentally aid the water circulation by drawing solid water from the throat sheet space, imparting heat during its backward travel, so that the discharge is mixed water and steam. These excellent results however are so in quality, but not in quantity, because the total heating surface added thereby is relatively small and the amount of water thus handled is proportional thereto. The Nicholson thermic syphon was devised and is in general use to compensate for these shortcomings, and also to provide a firm, adequate support for any desired brick arch. The value of Thermic-syphon circulation and increase of firebox heating surface has been demonstrated by its general use in America and abroad. The benefits derived in reduced staybolt breakage, as well as lengthened firebox and flue life were fully reported by a committee for the Master Boiler Makers' proceedings of 1931. With many designs of locomotive boilers, the back pair of drivers interferes with the application of lagging or cover for the wrapper sheet, and with a desire to promote the circulation at the sides of the firebox, a design of Thermic syphon has now been in service long enough to quite fully demonstrate a further improvement in the circulation.

Report by H. E. May

It is being brought to my attention through different channels that a great deal of trouble is being experienced on some other roads with side sheets checking, excessive staybolt breakage, etc. In my opinion, these troubles are due to improper maintenance, due in most instances, to failure of supervisory forces to give enough of their attention to those assigned to washing, blowing down

and filling boilers. I have found that this causes more fire checks in fireboxes than any other one thing. A second contributing factor is permitting scale clusters to build up around staybolts, causing the sheet to become unduly hot, the excessive amount of expansion and contraction resulting in cracking of sheets around staybolts.

The proper treating of water will eliminate the trouble with scale, but it will not prevent cracks in side sheets unless the washing and filling of boilers is done in the proper manner. I am confident that the standard practice for blowing down, washing and filling of boilers in force on the Illinois Central has increased our firebox life to such an extent that at the present time there is no way whereby we can anticipate just how long our fireboxes will last, and have reduced our staybolt breakage from an average of around five bolts per locomotive per month to one-sixth of one bolt per locomotive per month. Such performance as this certainly proves that it is up to the shop boiler force to maintain boilers, instead of expecting the chemist to do the whole job with feedwater treatment. They both go hand in hand, but one without the other is a waste of time and money.

I would also set forth the experience we have had with the American Arch Company's Security Circulators. We made our first application of these circulators to a Mountain-type locomotive, No. 2429, in August, 1934, which locomotive had last received a firebox in July, 1930, application being made to sheets which had already rendered four years' service. The results obtained caused us to apply three more sets: One set to locomotive No. 1143, in July, 1935, which received new side sheets in June, 1931; one set to locomotive No. 1053, in June, 1936, which last received a firebox in February, 1927; and one set to locomotive No. 1050, during September, 1936, which had received a firebox in June, 1934. Since the application of the circulators, these locomotives have made mileage as shown below:

Loco. No.	Mileage as of June 30, 1938
2429	220,040
1143	198,596
1053	118,974
1050	103,335

We have had no trouble with leaks, mud burns, blisters, etc., in these boilers since the circulators were applied and the conditions of sheets today is practically the same as when they were installed. In addition to this performance as to mileage and freedom from trouble with leaks, etc., these circulators, because of their design, have effected a considerable saving in the use of arch brick as compared with other locomotives of the same type in similar service.

Further I have been informed there are now 66 circulators installed in 15 locomotives operating on eight roads in the United States and Canada. These locomotives collectively have over a million locomotive miles to their credit since Security Circulators were installed in the first locomotive four years ago last July.

In not a single instance have the circulator units themselves required any maintenance, nor have they shown any signs of deterioration. There have been a few cases where joint welds at the side sheets have required attention, due to improper welding at installation, but these have not been serious and in no way have these leaks been considered a hazard.

While there have been no boiler-efficiency tests run on these circulator-equipped locomotives, day in and day out, operation points toward superior performance.

Another advantage brought out in service is more freedom from honeycombing and flue plugging. This, of course, must be due to the arch arrangement. A better proportioned arch is used and the baffle effect of the cross arms, which are exposed below the lower surface of the arch, probably has some effect in preventing some of the carry-over of partially consumed small particles of coal.

Results obtained to date indicate that firebox maintenance will be materially lowered. The first locomotive equipped four years ago carried its side sheets three years beyond what the renewal date would have been, adding about 200,000 miles to the life of these sheets.

The fourth locomotive to be equipped has been operating in the worst water country that could be found. In that territory, the life of arch tubes, syphons and side sheets is particularly short. This locomotive now has 30 months to its credit with a perfect record on firebox maintenance. Not only have the circulators been entirely trouble-free, but side sheets are reported to be as smooth and free from wrinkles and cracks as they were the day the locomotive was turned out with new side sheets and circulators. This cannot be said of any locomotives of the same class with comparable mileage. Present indications are that the side sheet life of this locomotive will be at least doubled.

The Proper Application of Flexible Staybolts

A discussion of two methods which have been used extensively for applying flexible staybolts

The committee members submitted individual reports on the following two questions: (A) Should flexible staybolts be set to a decided seat in the sleeves, cut to length and headed over on the firebox end? (B) should flexible staybolts be set to a decided seat in the sleeves and turned back one-quarter of a turn before cutting to length for heading? The committee suggested that the Master Boiler Makers' Association adopt method (A) as recommended standard practice; the reasons for this recommendation are set forth in the conclusion to this report.

Report by A. D. O'Neil

Although opinions differ concerning the most satisfactory method of applying flexible staybolts, my own experience generally favors the following method:

When applying flexible staybolts, subject each bolt to a preliminary seating, after which it should be slackened back one-half turn before being headed over and seated permanently. Firebox sheets are straightened and tack bolts applied to hold the sheets in alignment and insure proper water space. The balance of the holes are then tapped and the remaining bolts applied as outlined. Following application, the bolts should be cut off and headed over before tack bolts are disturbed, as all tack bolts will require resetting.

The practice of slackening each bolt one-half turn following preliminary seating is recommended to provide

uniformity of tension on each and every bolt involved. Obviously there are zones where one-half turn will prove insufficient and where it will be necessary to slack bolts back a greater distance. Bolts in syphon diaphragm plates adjacent to syphon necks are an illustration.

The development of flexible staybolts and their application to modern power represents one of the major advances in locomotive boiler progress. As such they should receive the utmost care in their application and maintenance. The methods for so doing as here set forth are based on many years of successful performance and hence recommended in lieu of alternate methods.

Report by F. Yochem

The practice on the Missouri Pacific is to apply flexible staybolts and radial stays to fireboxes and snub them in the sleeve after which they are cut off to length and driven. We do not deem it necessary or a good practice to slack the bolt off one-quarter of a turn after it has been seated in the sleeve since, in our opinion, slacking the bolt adds additional stress and strain in rigid staybolts or radial stays in that vicinity of firebox.

We realize on firebox renewal some of the holes in the new firebox sheets are not exactly in the same location as the original or first application, therefore, flexible bolt heads do not seat as freely in the sleeve as the original bolt did; therefore, we question the advisability of providing additional slack.

Report by E. J. Brennan

At the time flexible staybolts were adopted, it was the general practice to apply bolts turned back one-quarter to one-half turn. This was the method we used for a number of years with good results.

On boilers with full installation of flexible staybolts that had flush sleeves behind the cab, running board brackets and other fixtures, we encountered considerable trouble and expense in removing flush caps. After the third or fourth flexible staybolt test, the flush sleeves were so badly distorted that in most cases it was necessary to renew the sleeve, bolt and cap. We decided to eliminate the flush sleeves and apply hollow rigid staybolts. This was tried out on a few locomotives and after four years service the results obtained were satisfactory. As locomotives were shopped for heavy repairs, hollow rigid staybolts replaced flush flexible staybolts.

When we started applying hollow rigid bolts, the practice of applying flexible bolts was changed in order not to overload or stress the rigid staybolts. With the exception of flexible staybolts on the throat sheet around the syphon neck, all the rest are turned in to a decided seat in the sleeve. Over a period of ten years, on a check of 1,200 locomotives that have a full installation of flexible staybolts, we have not averaged over one broken bolt to a flexible bolt test. This is just as good, if not better than the record we had for the previous method for applying flexible bolts.

Staybolts are run in with a motor almost to a seat, then turned in the rest of the way by hand. The reason for finishing the application by hand is to take special care and know that the bolt is not bearing too hard in the sleeve, especially where the sleeves are old and have a tendency to be brittle, the vibrating or hammering caused by driving the bolt might possibly crack the sleeves if the staybolt were screwed in too tight.

Report by F. A. Longo

We must remember that the stresses on a flexible bolt are bending movements due to the unequal thermal expansion of inner and outer plates and vibration due to inequalities of track and speed of the locomotive. Added to these stresses is the tension of 7,500 lb. per sq. in. of cross-sectional area due to boiler pressure. This tensional stress is the only stress on a staybolt that can be accurately calculated.

The difference in temperatures between the inner and outer plates is governed by the firebox temperature, the amount of boiler scale adhering to the plates and by the speed of circulation of the water in contact with the plates. In addition we have vibratory stresses due to piston thrust and also drawbar shocks in the sudden starting and stopping of trains.

The types and classes of failure of staybolts is divided into two main divisions: First, broken or fractured bolts, and, second, failure of the joint between the bolt and the plate, causing leakage.

The broken bolts can be divided into two classes, the first of which is the slower or progressive crack type of fracture and the second, the sudden break. The fiber strain on the bolt which is responsible for failures of either type is governed by the following factors: (1) Diameter of bolt with relation to thickness of plate; (2) the fit of the bolt in the plate, as too tight or loose in the threads and (3) the shape of the bolt as to whether straight diameter or reduced shank.

All flexible bolts should be released slightly from close contact with the sleeve seat before riveting, because the riveting operation has a tendency to draw up the bolt. The following table gives the approximate clearance between the flexible-staybolt head and the sleeve by turning back, after it has touched the sleeve:

1/8 turn backward	1/64 in. scant
1/4 turn backward	1/64 in. full
3/8 turn backward	1/32 in. full
1/2 turn backward	3/64 in. scant
5/8 turn backward	3/64 in. full
3/4 turn backward	1/16 in. full
7/8 turn backward	5/64 in. scant
1 turn backward	5/64 in. full

A loose fit flexible bolt has a tendency to turn while riveting and the bolt takes much more driving to upset in hole. The fit in the sheet when bolt is run in must be such that the ordinary strength of one hand on a 12-in. wrench is just sufficient to turn the bolt in the sheet.

Bolts should be cut off parallel with the sheet for driving.

When driving up flexible bolts, the holder-on should be held securely against the head of the bolt with a 50-lb. or heavier standard dolly and riveting plug and kept central in line with the riveting blows.

In driving flexible bolts several hard blows must be struck in the center to upset the bolt in the sheet then rotate the air hammer counter-clockwise (this so the bolt does not screw out) on the bolt to knock down the edges.

Flexible bolts must be threaded to make a good fit in the sheet, fits either too tight or too loose are objectionable and cannot be expected to give good results.

Before applying flexible bolts, holes must be blown out with air to remove cuttings left in the holes during the tapping process.

Ends of bolts may be burned off to required length with an acetylene torch before driving.

When applying flexible staybolts covering large areas, the sheets should be held together by screwing a stud through the tapped holes, locating the studs every four or five rows and so spaced to prevent the springing in or out of the sheets when applying bolts or when bolts are being riveted over. All rigid staybolts in close

proximity to flexible bolts should be in place before the application of flexible bolts.

Conclusion

In addition to the foregoing reports, the committee received opinions from other members of the Association. In checking the replies obtained from various railroads, the committee found that a great majority of them followed the method of seating the bolts as outlined in Method (A) of the first paragraph of this report. Therefore, the committee suggested that the Master Boiler Makers' Association adopt Method (A).

Pitting and Corrosion of Boilers and Tenders

Committee reports present practice in repairing boilers and tenders

While the committee has endeavored to report on pitting and corrosion conditionings existing on all roads, obtained as the result of a questionnaire, a difference of opinion was found in some cases. Therefore, this report presents the practice in effect on a majority of roads for repairing locomotive boilers and tenders made necessary by pitting and corrosion of the various parts involved. Reports of individual committee members are as follows:

Report by J. P. Becker

A questionnaire was submitted on the following items which will be discussed in the order noted: (1) Pitting and grooving in boiler courses, (2) life of fireboxes, (3) life of flues and mileage between resetting of flues, (4) pitting and corrosion of locomotive tenders, (5) storing of boilers to prevent corrosion, and (6) the use of treated water and continuous blow-off.

Pitting and Grooving in Boiler Courses—Pitting and corrosion in boiler-course shell plates, usually confined to the area adjacent to waist-sheet supports, caulking edges, edges of washout plug holes, corrosion or grooving of sheets on the water side at the mud ring, front and back flue-sheet knuckles, etc., is caused by strains or stresses in the metal during the fabrication and when the boiler is in service. Due to the repeated changes of temperature in the boiler, a continual expansion and contraction takes place in the plate which causes the structure of the metal to break down in small localized areas on the water side of the plate, thereby resulting in pitting. These pits are usually located adjacent to waist-sheet angles where an added strain is imparted to the sheet.

Where right-angle flanges are turned on front and back flue sheets, it was found that cracks and corrosion existed on the bottom of the front flue—sheet flange radius and at the top and bottom flange radius of the back flue sheet. This condition was found in sheets of ½ in. to ¾ in. in thickness.

The flanging operation opens up hair-line cracks on the outside radius of the flange. Hair-line cracks were also found to radiate from rivet holes and staybolt holes due to improper fitting up of the sheets. These small cracks invite intercrystalline corrosion. Intercrystalline corrosion will also exist when the metal has been strained during fabrication such as rolling, punching, flanging and fitting up.

It is recommended, where excessive cold working or hot or cold flanging of the metal is done, that the sheet be stress relieved by annealing.

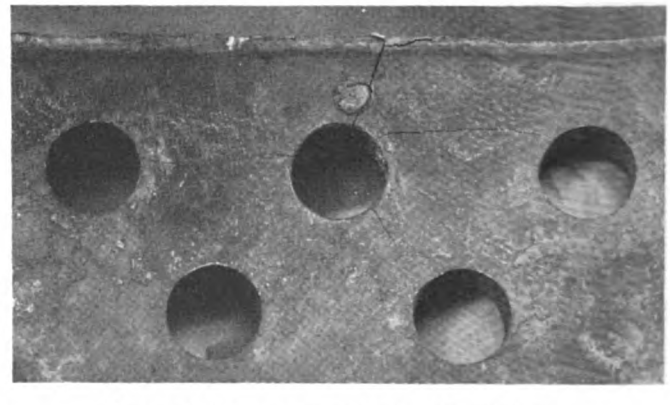
Life of Fireboxes—Prior to the time of establishing systematic feedwater treatment, side sheets in locomotives with 100 sq. ft. of grate area and 255 lb. per sq. in. boiler pressure required new side sheets in one to three years. While there is no doubt that more or less pitting and corrosion is set up during the fabrication, it must be admitted that the degree of cleanliness and attention to maintenance of the boiler is the principal factor in eliminating premature repairs.

Life of Small Flues and Mileage Between Resetting.—The elimination of pitting or grooving of flues is still a problem; however, the treatment of boiler water has reduced the tendency of pitting in flues.

Effect of Treated Water on Life of Boiler Parts

	With untreated water, years	With treated water, years
1—Life of fireboxes	4 to 8	10 to 20
2—Life of small flues	8 to 15	10 to 20
3—Time between resetting of small flues	1 to 2	3½ to 5
4—Life of superheater tubes	8 to 15	10 to 20
5—Time between resetting of superheater tubes	1 to 2	3½ to 5
6—Life of arch tubes	1 to 2	4 to 5
7—Life of syphons	3 to 6	10 to 15
8—Hours of miscellaneous hot work, per locomotive per month	120	60
9—Hours of bombarding sheets, per locomotive per year	96	24

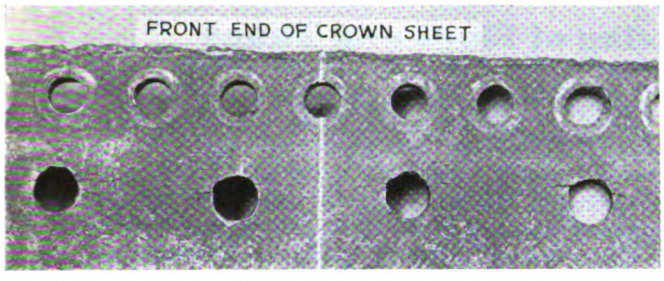
When long flues are placed in a horizontal boiler, sagging occurs at the center, which concentrates a stress at the front flue sheet, since the flue is rolled out from its original diameter and the metal is thinner and therefore subject to grooving. However, the end of the flue in the back flue sheet is strengthened by swedging to a smaller diameter, consequently increasing the original thickness of the metal. In the case of retipped flues, the safe end or new flue tip is applied at the back flue sheet, while the old part of the flue is rolled into the front flue sheet. In cases where grooving took place around the flue at the front flue sheet, a short piece of



Intercrystalline corrosion at circumferential seam

flue was rolled into the end of the flue and the strain was thrown over a greater area of the flue, whereas it had previously been concentrated at the edge of the flue sheet, and grooving resulted.

Pitting and Corrosion of Locomotive Tenders—The pitting of tenders in the water space is primarily due to



Cracks around crown bolts on the water side

water conditions, and may be corrected by treating the water or cleaning the surfaces and painting them with a protective covering. Corrosion in the coal space is due to the liberation of the sulphuric acid in wet coal. This condition can be practically eliminated with paints that are made for this particular purpose.

Storing of Boiler to Prevent Corrosion—A boiler when stored dry and clean will show only a minimum of pitting and corrosion, but when permitted to stand with moisture and dirt in them, they deteriorate very fast. It has been noted that a boiler in service properly maintained has shown less deterioration over a given period than a boiler used occasionally and indifferently maintained, which would also indicate that proper attention paid in servicing a boiler when stored, will pay dividends when the boiler is again returned to service. When it is decided to store a locomotive for a reasonably long period, the boiler should be washed and thoroughly cleaned on both fire and water sides, after which the dome cover and washout plugs should be expeditiously applied. Then the boiler should be steamed up to working pressure and blown down as hot as possible, thus permitting the high temperatures in the boiler to absorb all moisture. At this time a washout plug at the lowest point should be removed; also, all other places where water might be trapped should be drained. When it is ascertained that all the water is removed from the boiler, the washout plug should be replaced. The boiler will then cool off naturally, removing all possibility of sweating or trapping air, and will remain in this condition indefinitely without deteriorating.

Treated Water and Continuous Blow-Off—The application of continuous blow-off to locomotive boilers has proved to be very successful. On one division, locomotives were unable to make the next water stop when manual blow-off was used, but with the application of the continuous blow-off system, no difficulty was experienced with an adequate water supply between water stops. In recent test conducted on locomotives that were washed every 10 days, they have run 30 days before requiring washing after the application of continuous blow-off. This, however, did not dispense with periodic manual blow-off on the road, but it did reduce the number and duration of blow-offs approximately 75 per cent.

In summarizing the questionnaire, in order to ascertain the increase in life of various boiler parts since the advent of chemical treatment for boiler water, the results given in the accompanying table were obtained. The treatment of water with chemicals alone should not be given the entire credit for longer life and additional mileage of fireboxes and flues. Equal credit should be given to adhering to regular washout periods, following a definite schedule of blow-off on the road and at terminals, and complying with the method of treating water as recommended by the chemist. There is every reason to believe that repairs or renewals due to pitting or corrosion can be practically eliminated by scientific water treatment and constant supervision to see that all details relating to water treatment and care of boilers are complied with.

Report by W. B. Graham

The Missouri Pacific started the scientific treatment of boiler feedwater about six years ago, and there has been a very material reduction in the corrosion and pitting of our boilers, firebox sheets and flues. From a practical standpoint, the boiler department on our rail-

Comparing Operating Costs at Present Time with Conditions Prior to Extended Boiler Washout Periods

Number of boilers washed year 1931	22,149	
Number of boilers washed year 1937	2,465	
Average miles between washouts 1931	450	
Average miles between washouts 1937	3,795	
Total locomotive miles year 1931	9,968,922	
Total locomotive miles year 1937	9,355,500	
Number of boilers that would have been washed for 1937, based on average mileage between washouts in 1931, if treated water had not been used—(9,355,500/450)	20,790	
Number of boilers actually washed year 1937	2,465	
	18,325	
Annual saving in boiler washing (@ $3.50 per washout)		$64,137.50
Average months between flue settings prior to treating of water	25.8	
Average months between flue setting subsequent to starting of water treatment	44.9	
Increase in flue life since water treatment started	19.1	74 per cent
Average miles between flue setting prior to treating of water	83,163	
Average miles between flue setting subsequent to starting of water treatment	136,649	
	53,486	65 per cent
Number of engines that would have required flue reset in 1937 if untreated water had been used, based on average miles between setting prior to use of treated water (9,355,500/83,163)	112	
Number of engines requiring flues reset in 1937, based on average miles between setting since start of water treatment (9,355,500/136,649)	68	
Decrease	44	
Savings in cost of resetting flues 1 year (44 × $500.00)		22,000.00
(Note: Number of engines that actually had flues reset year 1937—57)		
Number of broken staybolts reported year 1931	839	
Average locomotive miles per broken staybolt reported	11,882	
Number of broken staybolts that would have been reported in 1937, based on average miles per broken bolt in 1931 (9,355,500/11,882)	787	
Actual number reported broken in 1937	661	
Decrease due to use of treated water	126	
Annual saving in broken staybolts (@ $1.00 per bolt)		126.00
Wages of running repair boiler forces year 1931	$90,839.92	
Wages of running repair boiler forces year 1937 (based on rates of pay in effect year 1931)	71,657.52	
Saving in wage of running repair boiler forces		$19,182.40
Grand total savings		$105,445.90

roads, by close supervision and compliance with instructions from the chemical department, can more than double the life of the flues, fire boxes and boiler sheets. The blow-down system as prescribed by the chemists in connection with the water treatment has been of great benefit, and a large saving in money over the lines that I cover in Texas. This is exemplified by the accompanying table.

Prevention of Cinder Cutting of Flues and Tubes

Practices in locomotive design and operation which prevent cinder cutting

Some railroads are experiencing cinder cutting on stoker-fired locomotives with detrimental effect on flue sheets, flues, staybolt and crown-bolt heads and various parts in the smokebox. The committee submitted two reports on this subject.

Report by S. E. Christopherson

Cinder cutting of present-day intensity in our modern coal-burning locomotives is due to the velocity imparted to the cinders by improper draft and by locomotive operation at high speeds and heavy tonnages. Most locomotives in high-speed service and making long runs are stoker fired and free steamers. Therefore, the high draft created by the locomotive has a permanent bearing on cinder cutting, since the faster the draft ejects the gases and cinders, the greater will be the amount of air that passes through the firebed; consequently, a much higher speed is developed by the cinder and the quantity is increased, thereby resulting in increased cinder cutting. With high draft on locomotives worked at full capacity, with little or no change in drafting arrangement, we should bear in mind that the advent of this problem of cinder cutting has coincided with the change in operating conditions.

It is the opinion of the committee that the cause of cinder cutting is in the front end. Under present-day operating conditions, which require maximum horsepower and the use of high back pressure to meet the desired result, it is impossible to eliminate cinder cutting; however, it could be reduced to a minimum by the engineer without reduction in speed. It is a known fact that, where exhaust pressures are controlled by the engineer from observation of the back-pressure gage or by mechanical means, there is a decided drop in the speed and amount of particles of coal being carried over the arch.

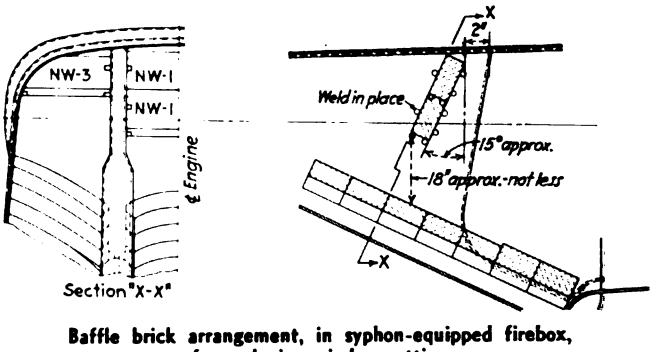
Various remedies to control or eliminate cinder cutting have been tried, but with very little success. These include lowering the arch tube at the door-sheet end, and reducing the number of bricks in the arch (in some cases it was reduced from ten to five in a row, but the steaming of locomotives was impaired and there was no help on the cutting). Beads welded in front of staybolts and crown bolts have diminished the cutting but never prevented it.

Where flue sheet and flues have been affected seriously by cinder cutting, a method has been found which has proven beneficial. This is the use of a baffle brick arch shown in the drawing, especially on syphon-equipped locomotives. This arrangement has been in service on one railroad for about one year; its use has eliminated cinder cutting, plastering or honeycombing of flues. Previous to this application, the expected life of flues was about 28,000 miles.

Where cinder cutting has worn staybolts and crown bolts, this baffle brick arch should give good results on a syphon-equipped locomotive. Further benefits can be derived from the use of a proposed corrugated brick arch, which can be used on both arch tube or syphon-equipped locomotive.

Report by O. B. Kobernik

Where excessive cinder cutting is present, a serious attempt should be made to analyze the smoke-box arrangement to see if it is possible to change the drafting of the locomotive in a way to reduce the velocity of the gases or the amount of draft. It is suggested that an



Baffle brick arrangement, in syphon-equipped firebox, for reducing cinder cutting

analysis of the actual gas areas be compared to those recommended by the A. A. R. as contained in the recommended revision of the Master Mechanics' Manual. If, as is generally the case, it is found that the stack and nozzle can be changed and a fuel saving realized, the result will naturally be a lower firing rate and less stack loss, with an attendant reduction in cinder cutting.

Under present conditions of operation, which require sustained horsepower and the use of high back pressures to meet the desired schedules, it is virtually impossible to eliminate stack loss entirely or overcome all cinder cutting. It is noteworthy that cinder cutting is less on those locomotives whose fuel performance is the best, this indicating the benefits of proper drafting.

Where cinder cutting has worn side sheet, crown sheet or syphon staybolt heads, the most effective means we have found of reducing this wear is by application of half-moon shaped beads of electric weld at the back side of staybolt heads approximately ¼ in. from edge of staybolt head. These half-moon heads of weld will be worn in time by the abrasive action of cinders and must be replaced. Straight welded beads have been tried in place of the half-moons but the straight bead did not give as much protection to the staybolt head.

Cinder cutting of syphon flanges has been largely overcome by applying vertical welded beads to the flanges. These beads of weld are also ¼ in. high and spaced approximately 10 in. apart. This breaks up the flow of cinders along the syphon flange and decreases cinder cutting at this location.

Flue sheets have not been seriously affected by cinder cutting; however, rivet heads and flange knuckles are affected, but no means of reducing cinder cutting at this location have been established.

Small tubes located near top of flue sheet on both sides of center line have been cinder cut on the inside of the tube at the bottom where the prosser recesses the tube. On some engines cinders have cut entirely through the small tubes after about 80,000 miles service. It is believed this condition can be overcome by raising the height of arch one brick after 40,000 to 50,000 miles service. This will change to some extent the direction of cinder travel, spreading the effect over a greater area, thereby reducing cinder action at any one location to the extent it would not be necessary to renew flues due to cinder cutting between shopping periods of engine.

To decrease cinder cutting of the boiler front, door and smoke-box ring, a 45-deg. iron casting can be set at the bottom of the smoke box against the boiler front. This casting has a 2½ in. by 2½ in. angle iron bolted to the top edge to deflect the cinders from the boiler front. This has helped to reduce the cinder cutting to some extent but has not eliminated it altogether.

Front-end doors have been protected by a baffle cut from such second-hand material as side sheets, to fit the inside diameter of door. This baffle plate is secured to the door by four studs with spacers between the door and plate. The spacers on the two top studs are longer, which allows the plate to set at an angle, the top of plate being about 5 in. from the door.

As an experiment, about a year ago a special curved deflector was welded to the edges of smoke-box liner and to the 45-deg. iron casting for the purpose of deflecting cinders toward the center of smoke box. This deflector has been effective in decreasing cinder cutting in the front end.

It also seems reasonable to assume that cinder cutting of smoke box in front of the diaphragm plate can be materially decreased by application of angle irons just ahead of diaphragm plate, formed to the radius of smoke box and extending from the bottom of the table plate to the top of the diaphragm plate.

Heads of cylinder-saddle bolts, which are subject to cinder cutting might be protected by a V-shaped plate secured back of the exhaust pipe and extending to the under side of the table plate. This plate would prevent the sudden interruption of the draft at the exhaust pipe, and permit the smooth flow of gases and cinders.

Cinder cutting has been found at the back face of superheater-headed flange joints to steam pipes. This may be overcome by the application of a plate shaped properly to fit the neck between the flange and header. The diaphragm plate would then be fitted to this plate instead of to the header.

Prevention of Cracks in Outside Throat Sheets

Practices which prevent cracking in the upper section of the throat sheet and around staybolt holes

It is universally recognized that the primary cause of cracked throat-sheet wings, that is, the upper section of the throat sheet, is the restricted contraction and expansion which takes place in that area due to the necessity of design wherein a circular barrel is joined to the rectangular firebox. The close proximity of the joints, throat sheet, barrel, and firebox casing restricts the expansion and contraction to a small area between the joints.

Supplementary Causes of Throat-Sheet Cracks

(a) *High Tension and Stresses*—The tendency of the irregular shape at the focal point of failure, that is, the throat-sheet knuckle, to straighten out horizontally due to temperature changes when the boiler is going from zero to full pressure and when returning to normal when cooling down, result in high stresses which cause failure. The more often and more sudden such temperature changes occur, the earlier will fractures develop.

(b) *Flanging Stresses*—Throat sheets, because of their peculiar shape are subjected to severe flanging strains, especially when fabricated by the one-operation method. Flanging of throat sheets should be a two-operation process, flanging the yoke first then reheating the plate for a second operation of flanging the sides. This would greatly minimize the strains.

(c) *Improper Fitting*—Pulling the wings and flanges into position by the aid of bolts and clamps, assisted by local heats from the acetylene torch will set up concealed strains. Hammering or forcing the sheet into position at a blue heat should be avoided at all costs. After such fitting up, the sheet should be removed and normalized in a furnace.

(d) *Restricted Movement of Boiler on Frames*—Over the length of the entire boiler, the expansion will be in some instances as high as 1¼ in. From the time the boiler is fired up this reaction is continual. It is therefore obvious that sliding blocks must be kept well lubricated and in a free operative condition.

(e) *Frequent Cooling Down of Boilers and Rapid Firing Up of Boilers*—These are factors which have a tendency to increase and aggravate expansion and contraction. Extending wash out periods to thirty days, longer locomotive runs to more than one division, and elimination of terminal cool downs by the use of direct steaming will have a beneficial effect upon these sheets and prolong their life. Strict attention should always be given to the practice of blowing off, filling of boiler, and firing up, so that the temperature should be changed gradually in order to give the plates a chance to expand or contract as normally as possible.

The committee has received many helpful suggestions which divide themselves into three groups: (1) Methods of repairing existing throat sheets; (2) change in design for riveted type of throat sheets; and (3) suggested design for welded type of throat sheets.

Method of Repairing Existing Throat Sheets

(*a*) Slight checks should be veed out to the depth of the sheet and welded with the electric arc. Do not reinforce the weld as it stiffens the plate at the section and cracks will develop along the side of the weld.

(*b*) When checks extend half way or more through the sheet, vee out the cracks, weld and apply a cover patch between the joints of the barrel and firebox casing on the inside of the boiler if accessible; if not, apply it on the outside. Rivets in this patch should be staggered between those of the barrel and the casing.

(*c*) If the sheet is heavily cracked, remove and apply a new wing section. Some prefer to lap the bottom joint and rivet it, considering this as an unstayed surface. It is the opinion of others that a welded joint made through

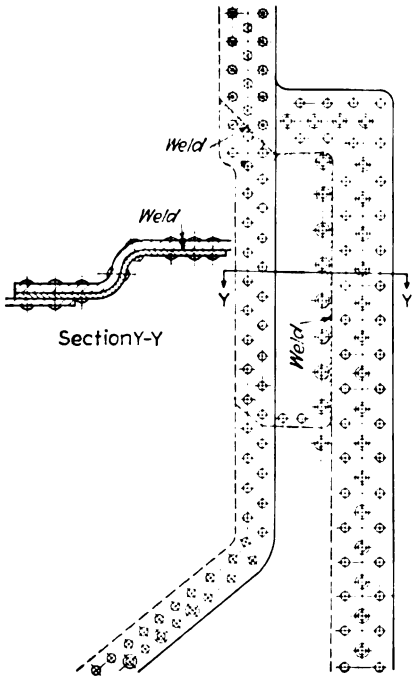


Fig. 1—Reinforcing liner applied to the water side of the outside throat sheet

the knuckle is adequately stayed, is economical and easy to apply. When a welded joint is used, the joint should be cut in a diagonal direction.

Throat-sheet wings should have as near a perfect fit as possible to minimize fitting strains. A good method is to make a solid ⅜-in. square iron skeleton gage to conform to the shape and outline of the section removed. When the new section is made to conform to this gage, no difficulty will be experienced in fitting in the new section.

The application of reinforcing plates to wing section have been tried with some success, and it is suggested

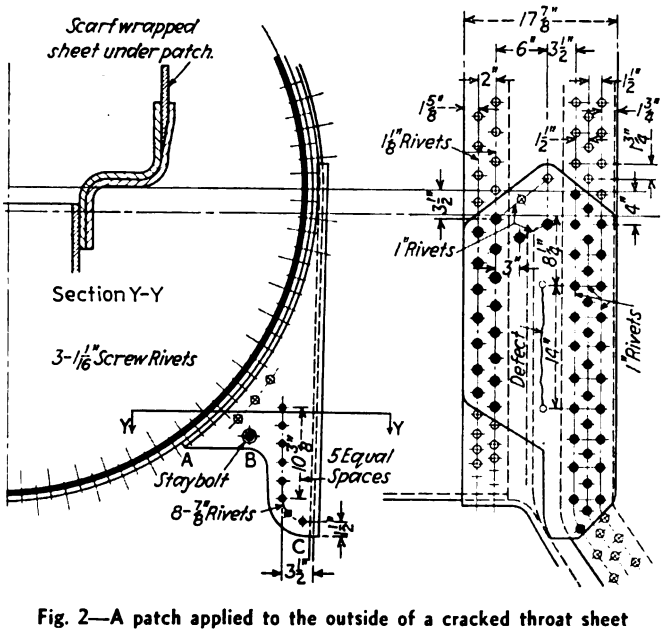


Fig. 2—A patch applied to the outside of a cracked throat sheet

that this be applied as a preventative of cracking to new sheet.

Fig. 1 shows the application of a reinforcing liner to the water side of the outside throat sheet to be applied to all new locomotives when built and to locomotives receiving new fireboxes when the throat sheet is not cracked. This liner should be made of material of the same thickness as the throat sheet, should fit securely

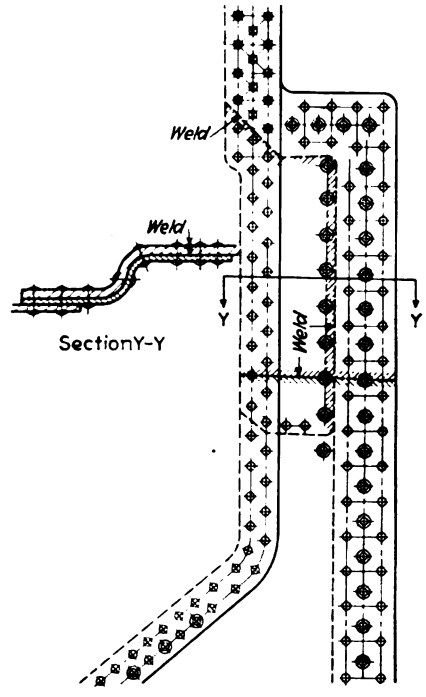


Fig. 3—Throat sheet repaired by welding in a new section and then applying the liner shown in Fig. 1

to the contour of the sheet and must be flanged with the grain structure of the sheet to receive the best results.

Two methods of repairing cracked throat sheets with the use of reinforcing patches are advocated, both of which have proven to be satisfactory in service. Fig. 2 shows a patch applied to the outside of a cracked throat sheet. This type of patch can be applied in the shop as a permanent repair or may be applied as a temporary repair in the enginehouse by the use of patch bolts.

A more satisfactory repair can be made by removing the cracked portion of the sheet, welding in a new section as shown in Fig. 3, and applying the reinforcing liner shown in Fig. 1 to protect the weld. This form of repair can only be made when the firebox sides and tube sheets are removed.

Fig. 4 shows a one-piece side-and-wing section with a welded joint between the first and second rows of staybolts. This flanged section would take care of the cracking in wings and ligaments between the outer rows of staybolts and the throat sheet.

Change in Design for Riveted Type of Throat Sheet

Your committee is indebted to G. M. Wilson, General Boiler Superintendent, American Locomotive Company for his suggested design of riveted throat sheet which has considerable merit and embodies a possible solution to this problem. He states: "Assuming the cause is due to design, the design makes necessary the usual shape. (knuckle) at which point fractures develop.

"Now if we redesign the flanges so as to eliminate the knuckle (double abrupt bend) by making a straight surface horizontally, we then remove the cause." The method used in so doing is shown in Fig. 5.

Suggested Designs for Welded Type of Throat Sheet

Welding technique is rapidly arriving at a high state of efficiency so that it will only be a matter of time before the barrier against welding joints in throat sheets will be removed. When this takes place it is believed much of our throat sheet trouble will be eliminated. A

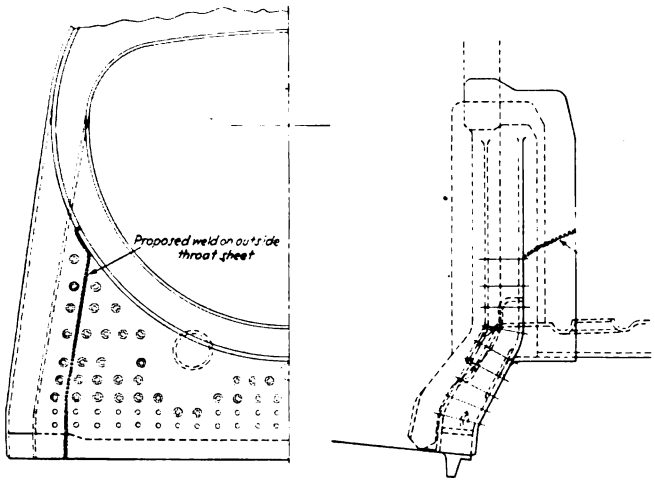


Fig. 4—One-piece side and wing section with a welded joint between the first and second row of staybolts

number of interesting suggestions have been made along these lines.

One suggested design of throat sheet is that in which the yoke of the throat sheet is welded to the barrel of the boiler: "The front flange is done away with and the shell course comes straight back and laps over the throat. It extends through into the water space the full thickness of the shell plate. Then a heavy weld is put on the water side of the joint, and light seal weld is applied to the outside to close any small opening in the joint. The shell course can be jacked down to the outside throat, iron to iron, making a good tight fit. The shell does not depend wholly on the weld, but is supported by a full bearing on the throat sheet which will run from 5/8 in. to 1 in. in thickness.

"If this type of throat were approved, it would be very easy to make and apply. Also, there would be a considerable saving in material, time and labor cost. In old power, now in service, the change could be easily made. If the throat is cracked and the shell pitted, all you would have to do is let the new half shell course extend back through the new throat sheet into the water space and weld it. The combustion-chamber type of boiler is entirely supported by staybolts in the shell and throat, and the boiler without a combustion chamber would have an extra row of staybolts in the throat sheet only."

In the 1936 Proceedings of the Master Boiler Makers' Association, page 88, there is material which can be considered as a worthwhile contribution to the subject under consideration.

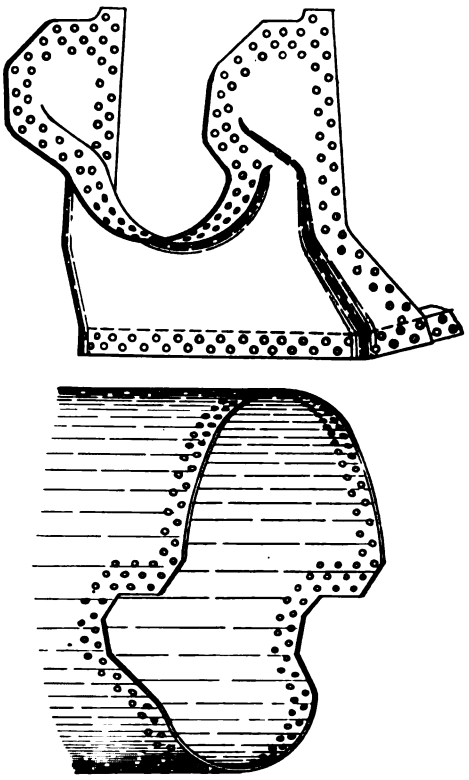


Fig. 5—Proposed design of throat sheet to eliminate the double abrupt bend of the knuckle

"Application of the outside throat sheet, (Fig. 9 of the reference) by the conventional method of flanging, fitting, drilling, reaming, chipping, riveting and calking causes this to become the most expensive member in construction to manufacture and apply.

"A saving of more than 50 per cent in material and labor costs is possible by substituting an electrically-welded throat sheet for the flanged type and a study of this feature reveals that an installation of ample strength and extreme simplicity can be made." [A complete description of applying this welded throat sheet is to be found in the reference just given.—Editor.]

Application of Waist-Bearer Angles

A discussion of the effectiveness of different types of waist-bearer angles or tees

The committee assigned to report on the subject of waist-sheet connections has endeavored to compile information from as many and as wide spread sources as possible, and toward this end a questionnaire covering the various phases of this subject was prepared and sent out. A very gratifying response was received from the members, a large majority of whom reported that they had experienced trouble with the conventional types of waist-sheet connections, and who suggested various changes in design which have been made to overcome or lessen the difficulties experienced with waist sheets.

The rigid construction, resulting from waist sheets

bolted or riveted both to angle irons or tees which are rigidly attached to the boiler shell and to frame crossties, causes strains to be set up in the boiler shell, due to expansion and contraction, which very often results in shell cracks at or near the ends of the angle irons or tees.

The shell cracks which result from this construction range from 1 to 2 in. in length to as much as 10 or 12 in. When such a crack is discovered the engine must be taken out of service and a suitable patch applied before the engine is returned to service, at which time an Alteration Report must be furnished to the Locomotive Inspection Bureau. If the flues are in the boiler and temporary repairs are made by applying the patch with patch bolts, these bolts must be replaced by rivets at the earliest opportunity, resulting in another job of stripping the engine. That trouble of this nature is of common occurrence is indicated by the fact that all of the members consulted reported this trouble except two who reported that there were no rigid waist sheets in use on the roads with which they were connected. A majority of the members indicated that their usual practice was to apply a diamond-shaped patch to reinforce the defect. In some cases the patch is extended from one side of the boiler to the other so as to anticipate cracking at the opposite end of the waist sheet, and also to provide a suitable bearing for the tee iron or angle after the patch is applied. One member reported that engines which gave trouble from shell cracks in recurring locations had patches applied when the engines were shopped and flues removed to do away, as far as possible, with the trouble expense and loss of service of the engine when cracks occurred.

As locomotives increased in size and speed, the trouble experienced with cracked shells at waist-sheet tee irons became so pronounced that steps were taken to improve the condition by changes in design of waist sheets. A number of the members who were consulted stated that whereas older power was nearly always equipped with rigid waist-sheet connections, modern power has floating waist-sheet connections, or waist-sheet tee irons rigidly fastened to a shell. About half of the members consulted, indicated that changes had been made in waist sheets on older power in order to improve conditions, many roads going to floating waist sheets entirely on certain classes of power. Other steps taken to improve conditions were the rounding off of the ends of the tee irons, cutting away the vertical leg of the tee or angle to give more flexibility, the use of laminated waist sheets, and the use of pivoted braces, especially at the guide-yoke crosstie.

In regard to changes in design of waist sheet connections on older power, the Committee was fortunate in obtaining a complete record of shell cracks for an entire class of 100 heavy Mikado-type freight engines, from the time they were built in 1918, to the present time. This information is shown in the accompanying table, and it will be noted that the first shell crack developed in 1923, after which there was an increasing number of shell cracks nearly every year until 1933. In December, 1932, a program was started in which the boilers of this class of engines were cut loose from the locomotive frame. The number of shell cracks occurring at the waist-sheet connections of these engines decreased as these boilers were cut loose, so that for the current year only one shell crack has been reported to date. It should be stated in this connection that as the boilers were cut loose, the connection at the front end of the firebox was improved by the application of a sliding shoe. No trouble has been experienced from increased frame failures or difficulty with smoke arch sheets or rivets due to this change in waist-sheet design. No wearing pads were applied to the boiler shell in this program, and engines which have been in service five years or more since the change was made show no appreciable wear on the boiler shell at the sliding waist-sheet supports.

Good results are reported by a number of members from the use of waist sheets where the tees or angles are riveted, studded or welded to a pad or liner which in turn is riveted to the boiler shell. This construction is, however, more costly and more difficult to fit up properly than the floating type of waist sheet. At this point, a word should be mentioned stressing the importance of proper application of floating waist-sheet connections. An improperly applied floating waist sheet was recently observed on a passenger locomotive where a groove $\frac{3}{16}$ in. deep and the full length of the angle had been worn into boiler shell on each side of the locomotive.

With the advent of cast-steel engine beds of great rigidity, the importance of waist-sheet angles or tees is questioned. When such beds are used some members recommend the elimination of waist sheets entirely, while others prefer the usual construction with two, three or even four waist sheets. The use of alloy-steel boiler shells has caused no perceptible change in waist-sheet difficulties. Increased speed of both passenger and freight engines in recent years has been thought by some to increase trouble due to waist sheets, while other members feel that if waist sheets are properly designed and applied, the speed of the locomotive is of little importance.

In connection with waist sheets used with cast-steel locomotive beds, one member reported the use of a novel arrangement where the waist sheet is fastened rigidly to a liner which is in turn fastened to the boiler shell. The lower end of the waist sheet, however, is bolted to a sliding shoe which moves in a bath of oil in a pocket cast in the locomotive bed. This would appear to be the perfect solution of the waist sheet problem, but could only be used on new power.

From the information received with the return of the questionnaires which were sent out, it appears that the members are about evenly divided between those favoring floating waist sheets, and those favoring the type where the waist-sheet angle is fastened to a pad or saddle

Relation of Boiler Shell Cracks to Rigid Waist-Sheet Construction*

Location of shell crack	Boilers Rigidly Attached to Waist Sheets										Floating Waist Sheets					
	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
First course, right side	0	0	1	0	0	1	1	2	5	5	3	2	2	1	1	0
First course, left side	0	0	1	2	2	2	2	0	2	3	1	1	2	2	2	0
Second course, right side	0	0	1	1	1	0	2	2	3	0	0	1	0	3	2	1
Second course, left side	0	2	2	1	2	4	3	1	0	2	5	2	3	1	0	0
Third course, right side	0	1	0	1	1	3	4	0	5	0	1	0	2	1	1	0
Third course, left side	1	0	1	1	2	1	9	2	10	3	4	1	1	2	1	0
Total	1	3	6	6	8	11	21	7	25	13	14	7	10	10	7	1

* Number of shell cracks developed in boiler shells at the ends of waist-sheet angles from 1923 to date on 100 2-8-2 type locomotives built in 1918 and 1918 and fitted with conventional waist sheets riveted to the boiler shell. In December, 1932, these locomotives were equipped with floating waist sheets as back-shop repairs were scheduled. Note the decrease in number of shell cracks after 1932 as floating waist sheets were applied.

which is rigidly fastened to the boiler shell. One member recommended a combination of rigid and floating waist sheets in which the boiler would be attached to the frame at the guide yoke where expansion would be at a minimum, and other waist sheets would be of the floating type. Another member recommended the sliding shoe type of waist sheet described in the preceding paragraph. Where floating waist sheets were recommended, the use of wearing pads on the boiler shell was unanimously favored, both for old and new power. In all cases, proper connections should be provided at mud-ring corners to take care of expansion and to hold the boiler on the frame. No agreement has been reached as yet as to the necessity for waist-sheet connections when cast-steel engine beds are used, but a majority of those questioned favored the use of waist sheets with the one-piece locomotive beds.

In summing up the information received, the Committee believes that:

1—Waist sheets should be used on all locomotives.

2—Waist sheets should be either of the floating type with the boiler free to move longitudinally; or, if a rigid connection is desired, the waist-sheet angle or tee should be attached only to the liner or saddle, which in turn is fastened to the boiler shell.

3—Wearing pads or liners should be used with all waist sheets.

4—Connections at the front end of the mud ring should be of the sliding shoe type with bronze liners. The back end of the firebox should be supported by an expansion plate, as deep as possible to provide flexibility, or by the sliding shoe type.

5—Care should be exercised in applying waist sheets to obtain proper bearing for the boiler shell.

There is evidently no unanimity of opinion among members of the Master Boiler Makers' Association as to just which type of waist-sheet construction gives the least trouble. The Committee believes that much good can be derived from a discussion of the information outlined in this report.

Honeycombing and Slagging of Flues and Tubes

A review of the causes of honeycombing and slagging, and methods of keeping flues, tubes and sheets clean

The economic operation of a locomotive is dependent to a great extent upon the element of keeping the flues, tubes and sheets clean, and the subject of honeycombing and slagging of the flues and tubes is not new. The importance of this subject is made evident by the fact that the Railroad Smoke Association of Hudson County of New Jersey had designated a committee to accumulate data for the enlightenment of its members on this most important subject of honeycombing and slagging of flues and tubes. Their majority report with the minority report as written by William G. Christy, Smoke Abatement Engineer of the Department of Smoke Regulation, Hudson County, New Jersey, were presented to the February 11, 1938 meeting of their association, and published in the April, 1938 issue of the *Railway Mechanical Engineer*.

Individual committee members presented their reports as follows:

Report by E. E. Owens

It is necessary that high firebox temperature plus ash of low fusion temperature plus excess draft exit in unison before honeycomb will form on the flue sheet in the firebox of the locomotive. If any of these conditions are lacking no honeycomb can be formed. For example, if high firebox temperature is not attained then the ash cannot or will not be fused when excess draft is present. If coal having an ash of low fusion temperature is not fired when a heavy ash bed is present along with excess draft, then the existing firebox temperature will not be hot enough to melt the ash. If excess draft is omitted in the firebox through the grates then the ash on the grates cannot be raised above the fuel bed and, since the ash remains on the grates, neither the firebox temperature or its fusion temperature will have any effect upon its structure as long as the draft is even through the entire grate surface and a burning crust of coal is maintained over the entire grate area.

The reason why one coal ash will clinker or melt at a low temperature and another coal ash will not clinker or cannot be fused or made molten under ordinary firebox temperature is governed by the quality of the ash and not by its substances.

It resolves itself down to this—honeycomb is nothing but a misplaced clinker and it is absolutely necessary to have excess draft to manufacture a clinker on the flue sheet. It is claimed by some that faulty drafting appliances in the front end, air leaks in the smoke box, leaky superheater units, leaky fireboxes, especially flues and tubes, are responsible for honeycombing.

While this is true to some extent, as I see it, they are defects that go to set up a condition which causes poor boiler performance which in turn causes enginemen to resort to excess use of the blower, heavy uneven fires and other abuses to the boiler which creates the excess draft necessary to produce clinker on the flue sheet.

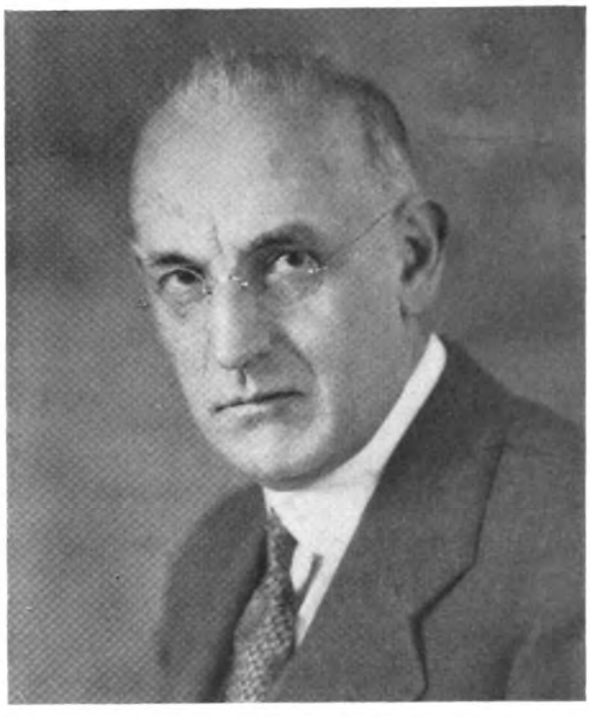
Taking everything into consideration, we as maintainers of power can do our part toward holding this trouble down to a minimum by keeping the boiler free from defects and see that it is properly drafted.

Report by J. A. Kahn

Causes of Honeycomb—(1) Honeycomb and slag are very closely related, both containing iron of some form combined with ash and silicon, but, honeycomb having a lower iron content with an increase in percentage of ash and silicon. (2) Any condition that retards combustion causes honeycomb and slag to adhere to firebox sheets, flues and tubes, such as leaky superheater units, leaks in smoke-arch, plugged flues, conditions of arch brick, defective grates, and leaks in firebox. (3) Uneven distribution of fuel causes holes in the fire which increases the velocity of gases in such locations; the high-velocity gases and pick up the plastic ash and deposits it on the firebox sheets, flues, and tubes in the form of slag and honeycomb. An improperly drafted locomotive is also a contributing factor.

Prevention of Honeycomb—(1) Selected coal with a minimum amount of sulphur and iron play an important part in the reduction of honeycomb and slag. (2) Follow good firing practices. Keep a clean, bright, level

(*Continued on page 451*)



K. F. Nystrom, President



E. J. Robertson,
First Vice-President



C. J. Nelson,
Second Vice-President

Holds two-day annual meeting at Chicago, well filled with intensely practical reports and discussions

Constructive Work Continued by

Car Men's Association

THE Car Department Officers' Association held a highly interesting and successful two-day annual meeting September 27 and 28 at the Hotel Sherman, Chicago, the attendance being substantially above expectations, considering the present drastic urge for economy and reduction of traveling expenses. Individual railroads supported the meeting to the extent of sending 115 responsible car department officers and supervisors, and there were 76 supply men in attendance, or a total registration of 191. The intensely practical committee reports and constructive discussions indicated that this association has a very definite place in the railway program to improve car conditions.

The meeting was presided over by President K. F. Nystrom, mechanical assistant to chief operating officer, Chicago, Milwaukee, St. Paul & Pacific, who made the opening address. The meeting was also addressed by Dr. Roy V. Wright, editor, *Railway Mechanical Engineer*. Committee reports were presented on the following subjects: Freight- and Passenger-Car Construction and Maintenance; Shop Operations; Facilities and Tools; Passenger-Train Car Terminal Handling; Lubricants and Lubrication; Interchange; Freight-Car Inspection and Preparation for Commodity Loading; Loading Rules; Billing for Car Repairs; and Painting.

President Nystrom's Address

In opening the meeting, President Nystrom said that railway car men are faced with a number of difficult problems primarily as a result of reduced business and railroad traffic which have resulted in a large amount of deferred maintenance and replacement of equipment. He said that one-half of the equipment in service in 1929, or approximately 1,000,000 cars, will have to be replaced with modern equipment before the railroads will be in a position to handle again with maximum economy car loadings in excess of one million a week. Car designs of even ten years ago are no longer satisfactory and Mr. Nystrom said that car men must be prepared to supply specifications for modern up-to-date equipment which the railroads should acquire as soon as earnings and financial conditions permit.

With regard to maintenance, Mr. Nystrom said that modern cars comprise 90 per cent or more of welding and that former methods of making repairs at many small division repair tracks will eventually have to be discontinued in favor of more extensive and permanent repairs, made on an annual basis at a limited number of shops well supplied with modern welding equipment. This will permit operating cars for a year without attention except lubrication and lubrication difficulties will be solved when the much-desired day comes that roller bearings can be economically adapted to use on freight cars.

Mr. Nystrom also stressed particularly the problem which confronts the railroads in training new car supervisors and craftsmen to fill the vacancies of men now approaching the retirement age. The work normally done along this line has been limited or overlooked entirely in depression years and must be resumed again at the first practicable opportunity, the greatest possible care being exercised both in the selection and training of new supervisors and shop employees.

Remarks by Dr. Wright

In addressing the association, Dr. Roy V. Wright extended congratulations on the character of the program and particularly the discussion which he said was most

stimulating and got down to "brass tacks" on many important matters relating to car construction and maintenance as well as interchange practice. Dr. Wright said that the entire transportation picture has changed during the past few years and a definite demand stimulated for improved services in the handling of both freight and passenger traffic. Railways must face the competition of the highway, and of water and air transport. This means that there must be an unremitting search for ways and means to improve railway equipment and facilities of all kinds.

Dr. Wright said that the railroads must not only provide modern equipment of improved types, but car men are faced with the problem of maintaining and servicing this equipment so as to meet competitive forms of transportation on an even basis. To do this work effectively, both a suitable organization and necessary shop equipment are absolutely essential, and Dr. Wright here concurred in remarks made by President Nystrom regarding the urgent necessity for adequate training of car-department personnel.

In discussing this point further, Dr. Wright said that the greatest problem of the railroads as well as general industry is the human problem and that the supervisor is the key to the situation, since he must interpret management to the workers and workers to the management. Supervisors who become engrossed in mechanical details and overlook the human element are failing in the most important part of their job. Dr. Wright closed with the comment that the difficulties now confronting railway car men are a definite challenge to their thinking and ability and that there is a large place for the Car Department Officers' Association in helping car men meet this challenge.

In replying to Dr. Wright's remarks, President Nystrom paid tribute to the constructive information presented in both the advertising and editorial pages of the *Railway Mechanical Engineer* and said that, without the hearty support of this publication and its editorial staff, the present meeting of the association would not have been held.

Election of Officers

During the meeting, the association elected the following officers for the ensuing year: President, C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, Chicago; first vice-president, W. E. Dunham, general superintendent car department, Chicago & North Western, Chicago; second vice-president, J. S. Acworth, superintendent of equipment, General American Transportation Corporation, Chicago; third vice-president, A. J. Krueger, superintendent car department, N. Y. C. & St. L., Cleveland, Ohio; fourth vice-president, E. S. Smith, master car builder, F. E. C., St. Augusine, Fla., and secretary-treasurer, F. L. Kartheiser, chief clerk, mech. dept., C. B. & Q., Chicago.

The following directors were also elected: H. H. Urbach, mechanical assistant to executive vice-president, Chicago, Burlington & Quincy, Chicago; C. Claudy, master car builder, Grand Trunk Western, Battle Creek, Mich.; P. P. Barthelemy, master car builder, Great Northern, St. Paul, Minn.; S. O. Taylor, master car builder, Missouri Pacific, St. Louis, Mo.; J. M. Brophy, superintendent car department, Illinois Central, Chicago; H. H. Golden, superintendent A. A. R. interchange and accounting, Louisville & Nashville, Louisville, Ky.; W. A. Bender, master car builder, Alton, Chicago; G. E. McCoy, assistant general superintendent motive power and equipment, Canadian National, Toronto, Ont.; E. M. Wilcox, assistant superintendent of equipment, New York Central, Chicago; J. E. Keegan, chief car inspector, Pennsylvania, Chicago; C. E. Strain, superintendent car department, Pere Marquette, Grand Rapids, Mich.; John Gogerty, assistant general superintendent motive power and machinery, Union Pacific, Cheyenne, Wyo.; J. P. Morris, mechanical superintendent, A. T. & S. F., Ft. Madison, Iowa; J. A. Deppe, superintendent car department, C. M. St. P & P., Milwaukee, Wis.; O. F. Davisson, superintendent, Armour Car Lines, Chicago; J. J. Root, Jr., assistant to vice-president, Union Tank Car Company, Chicago; J. W. Fogg, vice-president, MacLean-Fogg Lock Nut Co., Chicago; L. H. Gillick, assistant to vice-president, Vapor Car Heating Co., Chicago.

Recent Trends in Equipment Painting

By L. B. Jenson

Passenger Shop Superintendent Chicago, Milwaukee, St. Paul & Pacific

In the railroad equipment field, you will recall that only a few years back each road had one or two conventional colors. The locomotive was, of course, black, which color was standard from nearly the engine's birth. Passenger cars were more or less painted in the so-called Pullman color on most roads, although some rail-



W. E. Dunham,
Third Vice-President



J. S. Acworth,
Fourth Vice-President



F. L. Kartheiser,
Secretary-Treasurer

roads had their own individual colors, and still maintain them. But during recent years the demand on the railroads by the public for speed changed the painting materially. As each road introduced its new streamliners, the old morgue colors were changed to combinations of lighter colors, and a new alloy, stainless steel, entered into the outside finish of streamliners. In fact, during the past few years the painting of locomotives and passenger cars has become so very important that many railroads have engaged the services of high-class designers to decide on the decorative schemes.

The services rendered by the high-class designers of equipment have been very valuable, inasmuch as their views and thoughts were entirely different from what we railroad men had been accustomed to. That their work was well done is evident in the beauty of the new trains built in the past few years. That the public appreciates these trains is proven by their increased patronage of these trains. However, while the services of these designers has been valuable, the services of the painter foreman has been equally so because it was up to him to carry out the wishes of the designer. This meant that the painter foreman has had new and varied conditions to meet in the application of numerous color schemes to make trains outstanding.

New Paint Materials Must Be Durable

In the new-built trains of today emphasis has been placed on light weight and speed, with the result that many new metals have been employed in the construction of the locomotives and cars. The use of these different materials has created painting and cleaning problems. The attractiveness of the color scheme on trains is lost unless the paint materials which are applied are durable and tough enough to hold their colors during the interim between shoppings. Likewise, the highly colored trains must be kept clean.

Streamlining the modern locomotive, either Diesel or steam, makes it a thing of beauty and an integral part of the train. The new steam locomotive of today, streamlined and having the same color scheme as the cars, completes the artist's idea of beauty in railroad equipment. It has been possible to use the same color scheme and paint materials on locomotives as on cars because the jackets of the new locomotives have been insulated against heat. Again, the attractive value of these locomotives is nil unless the color scheme is permanent so as to permit of numerous cleanings.

The interior finish of passenger cars, whether of wood or steel, has undergone the same radical changes that the exterior has as far as color combinations are concerned. Roads that maintain inside steel finish entirely are, of course, up against the same problems as confront them on the exterior. Proper materials must be made, used and correctly applied so that they will adhere properly, be tough to allow of frequent cleaning due to light colors, and be non-fading. New paint materials introduced during recent years have eliminated much of the trouble formerly caused by steel interior finishes. Nowadays, for example, steel surfaces that are properly prepared before paint is supplied, do not shed their finish when subjected to sudden changes in temperature.

Wood Interior Finish Successfully Bleached

Roads that maintain wooden interior finish have been confronted with many changes during the past few years. The mahogany finish that was standard on many roads for many years is being superseded by other woods. That this has created paint problems is well known at Milwaukee shops where 61 new passenger train cars were built this year in which white maple and walnut finish predominated. To bring about the uniformity and beauty of these woods it was necessary to bleach them. This bleaching was an entirely new problem and there was considerable doubt whether the bleaching would have some detrimental effect upon the succeeding coats. It did not.

There need be little said on the painting of freight equipment except to note that quicker drying materials have resulted in shorter tie-ups of cars on repair tracks. Also, tests have proven that these quicker-drying, sprayed on materials are equal or better than the old-time oil and mineral paints which were brushed on.

During recent years radical changes have been made in the method of applying paint. Spray painting has been adopted by many roads for both exterior and interior work. It is sufficient to state that Milwaukee shops have found their up-to-date spraying systems to be indispensable to the economical operation of their car shops.

The radical changes made during recent years in locomotive and car construction and decoration have brought about great changes in the manufacture of railway paint materials. We now have the synthetics, both colors and clear varnish; the synthetic enamels in gloss, semi-gloss and dull; and the lacquers, which have been standard on some roads, and the improved lacquers. One example of the use of these new products on railroad cars will suffice to show their importance. Roads using the all-welded steel car have found that high lustre finishes bring out and magnify the imperfections caused by welding. By using the semi-gloss or dull lacquers or enamels, the appearance of surface distortions is practically eliminated. Also the painting time is reduced by quick repetition of the coats.

The paint manufacturers have keep abreast of the times by constantly improving and experimenting to give the railroads more durable finishes than they have ever had, which means that equipment can stay in service longer than previously with a good appearance. Each manufacturer, of course, has his own individual lines which he advocates and recommends, but it is only possible for men such as the foreman painter to determine by common interest and study, and by daily contact with painting, the real value of these different materials.

In the foregoing paragraphs I have tried to indicate the importance of a foreman painter's problems and work. Now I want to make an appeal especially to those roads that have dispensed with the foreman painter or better still, with the master painter as he was called some years ago. As you know, a year ago I asked for recognition of the Painter Foremen's Section of this association, and it was agreed that the Car Department Officers' Association would take us under their wing until such time as we could get recognition from the A. A. R., and restore the original painting section of the A. A. R. I endeavored, with the help of others, to revive interest in the painters' association, but did not get far, due to the fact that many of the old time master painters had either retired or passed on, and the younger generation who had taken their place were not given the backing by their superiors, that the former heads of painting enjoyed. In some cases that I know of, the foreman painter had even been dispensed with entirely, and supplanted by either a lead man or the painting is just a craft under some other department or general foreman.

Painting Supervisors Should Receive More Recognition

If there was ever a time that the master painter or foreman painter, whichever you please, is needed, it is now. With the many intricacies of painting, a knowl-

edge of the materials and methods being used on high-class equipment is most essential. While paint and painting is not an expensive part of the repairs to cars, it can be made so very easily by the wasting of paint material and its wrong application, bringing about cracked and chipped surfaces on cars and the necessity of repainting. Unless the proper application of paint material is made, it is a total loss to the public and to the railroad on which it is used. In these times when practicing economy and striving by greater efforts to produce a finished article which appeals to the public is a necessity, the former painter should receive due recognition. Instead of railroads curtailing the services of the foreman painter, they should increase his authority, and make him a component part of the organization with authority in conjunction, if you please, with the chemist, to produce lasting work.

There is no superior officer to a foreman painter who is capable of deciding the proper materials for application to be used on either locomotive or passenger equipment unless he has made a thorough study of painting. Painting is a study by itself and only those who are intimately associated with it day in and day out can make a success of it, and know what is right from wrong. I am proud of the painting on the system with which I am connected, and while I am not directly in charge of painting, I am responsible for it, and take as great an interest in the painting of our equipment as I ever did. Therefore, I should like to urge most strongly that superior officers encourage the restoration of the painters' association, giving the foreman painter the authority to attend meetings, or otherwise assist, so that we may get back again the days when there will be a natural interchange of thought and experiences, and painter foremen are encouraged to make a life study of their work. If the value of this were appreciated by the higher officers, I am sure in my own mind, that there would be no question that the painters' association would be restored to its original status. I am satisfied that this restoration would be a good investment and that it would result in sound economy.

Report of Committee on Lubrication

Types of oil for roller bearings—A method of applying packing to journal boxes

It is hoped during the ensuing year business conditions will improve to such an extent that your committee will be in a position to hold meetings, and by so doing, give the subject more detail study, resulting in definite recommendations which can be presented at the meeting next year. In handling the general subject of journal bearing lubrication, it should be borne in mind that the lubrication requirements of both freight and passenger train cars vary due to difference in local conditions such as extremes in seasonal temperatures, territory through which trains are operated, speeds, track curvatures, etc. The oil-saturated waste method of lubricating car journals is still in more or less general use excepting on passenger-train cars on which roller-bearing assemblies have been installed.

Roller-Bearing Lubrication

The lubrication of roller bearings is not an intricate problem to maintenance forces as the manufacturing and lubricating of roller bearings has been given close study on the part of the manufacturers, and also experts representing the various oil companies together with railroad lubrication engineers. They have developed a grade of oil which will, in their judgment, give the most satisfactory results with the various types of roller bearings. Since the mechanical features embodied in the several types of roller bearings differ widely as do speeds and other operating conditions, it is, therefore, to be expected that several different grades of oil will be required for general use.

We find that there are different methods which may be followed in successfully lubricating roller bearings: All-year oil for both summer and winter service; complete change of oil for summer and winter service; the blending method, which consists of using summer and winter oils, but not making a complete seasonal change. Starting in the early spring, oil additions are made of the summer grade, while early in the fall the added oil is of the winter grade. When complete change of oil is necessary, the seasonal grade of oil is used. In cold climates and where boxes are otherwise likely to collect moisture, it is necessary to guard against this on account of the possibility of losing the oil and freezing the roller-bearing assembly.

There are a number of patented devices in use in which pads, wicks or other mechanical devices substitute for waste. Most of these are either being used for test purposes or are in the experimental stage. However, we know of one large Class I railroad that has equipped 41 suburban coaches with the Kendall lubricator pads. These pads have given very satisfactory results since they were installed, and have now been in service approximately 2½ years.

Saturated Waste Method of Lubrication

The general journal-box assembly used in connection with oil-saturated waste method for lubricating car journals we believe you will agree, is far from being satisfactory. There is room for improvement in properly fitting and maintaining the lid over the journal box opening, and having an effective spring which will keep the lid tight, preventing foreign substances from entering the front of the box. We believe you will agree that in a large number of cases the journal box lids, particularly on freight cars, are not being properly maintained.

The dust guard is another important and possibly, in many instances, a forgotten item in connection with proper journal lubrication. The so-called standard dust guard leaves much to be desired in effectiveness and in doing what is expected of it. This, you will agree, is a very important item in connection with successfully eliminating hot boxes due to dirt or snow entering the box at this location. Therefore, in our opinion, it is of the utmost importance that the dust guards be properly fitted and maintained to promote successful lubrication of car journals.

The proper grade of oil is a very important item in good journal box lubrication. We find that the practice of using new oil for passenger car lubrication seems to be quite general with the majority of railroads.

The quality and characteristics of car oil are of the utmost importance. In summer, or in mild climates, the oil problem in itself is not difficult. In extremely cold temperatures, however, the characteristics of the oil become very important. It is under winter conditions that lubrication troubles multiply. Moisture enters the journal boxes and causes sogginess of packing. A compounded oil that will partly emulsify under such conditions cannot be expected to give the best results. When a car stands for a period of time in extremely cold weather the oil freezes. If the oil is such that it becomes sticky and gummy, trouble with disturbed packing and waste grabs is to be expected. It has been found that in extremely cold weather a cut back or a thinner oil is being used very successfully by adding a small amount to the journal boxes on cars which have stood any length of time and which provides sufficient immediate lubrication to the journals until such time as sufficient heat is developed to provide proper lubrication from the oil in the packing.

There also exists a wide range of opinions as to what constitutes the best waste for packing passenger car journal boxes. The preferences run to skein wool yarn. Axminster yarn, mixed wool waste, spring cotton packing, wool and cotton mix, special waste containing stiff fibrous materials and several grades of cotton.

Spring packing, some wool and some fibre treated wastes have more resilience than others and are the choice where resilience is given a prominent place in waste selection.

In choosing a wool waste for extremely cold regions, the selection should be a waste that is free as possible of loose lint and shredded or fluffy materials, as these have a tendency to break the oil film between the brass and the journal. A number of railroads use a good grade of cotton waste for the reason that it is practically free from lint. However, this kind of waste tends to become soggy when more or less moisture gets into the box.



In the preparation of new and renovated packing all railroads do not follow in detail the standard practice as outlined in Rule 66. One of the large Class I railroads which does not conform in detail with A. A. R. standard practices in this respect, shows an increase in freight service, from 146,659 to 192,034 miles per hot box and a decrease in average train delay per 100,000 miles from 13 to 10 min. in 1937, compared to 1936. In the same period in passenger service, miles per hot box increased from 253,047 to 725,002 and the average train delay per 100,000 miles decreased from 9 min. to 4.

In this method of packing, a suitable size roll of loosely twisted packing of sufficient size to fill the bottom portion of the rear end of box is used. This roll is placed against the back wall of the journal box in order to properly lubricate the fillet end of the journal and to keep out foreign substances. The packing between this rear roll and the wedge at the front end of the journal box is applied in two separate sections as follows: A suitable amount of packing is made into a loosely twisted roll sufficient in size to fill bottom of box, extending about one-half of the distance between the rear packing roll to the fillet of the journal and the collar. A second roll is made in a like manner to furnish lubrication for the balance of the journal extending up to the collar. The ends of the packing in these rolls are tucked down at the side walls of the journal box, and no part of the packing in the box extends above one inch below the center line of the journal.

A suitable and separate piece of packing to form a front plug or dirt seal is placed in front end of journal box. Any loose ends or strands are carefully tucked down at the front end of the box and this plug is not permitted to extend above the balance of the packing in the box.

In addition to using lubricating materials of a good grade and quality, satisfactory journal lubrication depends not only on the proper application of the packing in the journal boxes, keeping it one inch below the center line of the journal to insure against hot boxes as the result of waste grabs, but it is equally as important to insist upon careful attention of the journal box and its contained parts. The journal itself should be straight and perfectly smooth. Too much attention cannot be given to the finish of the journal. The practice as indicated in the Wheel and Axle Manual should be followed in machining axles and finishing journals. Careful attention should be given journal bearings, wedges and dust guards, when applied in connection with wheel changes, to insure that journal bearings are of the correct length and have a positive initial crown bearing and that the wedges should also be carefully checked in connection with periodic repacking journal boxes and all defective parts renewed.

The report was signed by Chairman L. R. Wink, assistant superintendent car department, Chicago & North Western; P. Maddox, superintendent car department, Chesapeake & Ohio; P. P. Barthelemy, master car builder, Great Northern; F. B. Lewis, general car inspector, Union Pacific, and R. Knorr, supervisor car repairs, Erie.

Discussion

In discussing the report on lubrication, President Nystrom said that roller bearings of today are either more reliable than those applied ten years ago, or the

railroads know how to take better care of them. The Milwaukee has 200 passenger cars equipped, with a record of two years' actual service without a failure. Condensation in winter sometimes causes water to accumulate in the boxes and wash out the lubrication, a condition which must be avoided by periodic checking, especially in the winter time. In changing wheels at shopping periods the roller-bearing units are removed from the journals, cleaned thoroughly and inspected with the utmost care to discover defects which would otherwise cause service failures. Defective roller bearing parts are replaced. This careful inspection and renewal is one of the prices which must be paid for the satisfactory performance of roller bearings in railway service.

F. G. Moody, master car builder, Northern Pacific, said that, with A. S. F. type roller-bearing units, the practice is to supply oil every 30 days. The oil level is checked once a week and a minute inspection made at each shopping. During the past year two oils were used in lubricating these roller bearings.

One member said that "Roller bearings are the answer to the car man's prayer," since with proper attention they entirely overcome hot box difficulties. C. A. Mick, mechanical inspector, Chicago, Burlington & Quincy, said that roller bearings are checked for oil level on Burlington three-car trains every 4,000 miles and on the larger trains once a week. Wheels are changed on an average every two months or 60,000 miles, thus automatically preventing water difficulties. A seasonal oil is not used. In December, the Burlington starts the addition of blending oil which is used until the middle of March, this blending oil being a good lubricant and giving a quick start.

In discussing the lubrication of freight car journals, one member said that no railroad can be sure it has summer oil in the summer time and winter oil in the winter and that, therefore, a one-year-round oil is desirable. He credited a record of 750,000 miles per hot box to the effective operation of Rule 66, and said that 50,000 miles per hot box used to be considered a good performance. The use of too much oil makes the packing swim and causes waste grabs.

F. E. Cheshire, general car inspector, Missouri Pacific, said that primary difficulty with hot boxes occurs not in winter months as many suppose, but are the worst in June, July, August and September. Mr. Cheshire said that an analysis of hot boxes over a 17-day period on the Missouri Pacific indicated that only one out of four



caused train delays and that the real trouble is usually due to mechanical conditions which must be corrected. He said that the present design does not provide for proper tolerances.

C. A. Mick, mechanical inspector, Chicago, Burlington & Quincy, stated that if the proposed A. A. R. oil specifications are adopted, they will involve either the distillation or chemical treatment process and there is some question if this expense is justified. He suggested the development of specifications for packing as it goes into the journal box, thus permitting individual roads to meet the packing specification with their own combination of oil packing and waste. A motion was passed that this be referred to the A. A. R. Mechanical division.

E. S. Smith, master car builder, Florida East Coast, said that present standard journal boxes will be in service a long time and must be maintained and operated. A. A. R. specifications should be adhered to, particularly with reference to wheel mounting, as he finds hundreds of instances, for example, where wheels are not properly centered as pressed on the axles.

(The committee report was accepted.)

Report on Shop Operation, Facilities and Tools

Jacks, cranes, hoists, trucks, portable electric equipment and welders are discussed

Your committee has been forced to rely solely on correspondence in the consideration of its subject matter and, since the request was made that the committee be concise and cover one or two specific items of particular importance, this report deals with the subject of facilities for freight car repair shops only.

Car Pullers—Modern car pullers will be found very useful as time-savers for moving cars in and out of the shop and spotting them in the various positions, especially where the progressive method of moving cars through the shop is used. There are many efficient types of car pullers available and in use, some of which have been designed and built in railroad shops. The use of car pullers in connection with the progressive system is considered more efficient than tractors since they enable the entire line to move at one time.

Overhead Crane — In designing shops, provision should be made for overhead cranes to facilitate the raising of car bodies from trucks, handling of heavy materials, etc. Such cranes should preferably have runways extending the full length of the tracks on which repair operations are carried out. A lifting capacity of from 10 to 15 tons is generally considered ample with lifting speeds of from 22 to 25 ft. per min. Usually with an increase in lifting speed, the capacity of the crane must be sacrificed. The number of overhead cranes

required in any one bay will depend on the methods employed in routing cars through shop and also the number of cars handled per 8-hr. shift. However, with the progressive system in use, it is generally considered that one crane in a bay can serve up to three tracks, each having a capacity of 12 cars in the repair positions.

Truck Repairs — The use of a portable tripod with suitable chain or ratchet hoists for handling of truck repairs will be found helpful in facilitating such work. Such facility makes easier for the employees the changing out of wheels, truck sides and bolsters, and therefore results in such operations being carried on in less time than where the work must be done by more laborious methods.

Air Jacks—Air jacks of suitable height mounted on low wagons should be used for lowering and raising of draft gears. Where such devices are in use the work of replacing draft gears or removing them for inspection can be carried on more efficiently and in a safer manner than where an ordinary jack is used to carry on the work.

Paint Facilities—Where the design of a shop permits, facilities for painting cars before moving them out of doors are an important consideration. Delays caused by moving cars, ready for painting, from one shop to another are avoided. Furthermore, there is no delay or hindrance to proper painting due to inclement weather which is so often the case where such work is done out-of-doors. With the spray method of painting in general use, it is desirable to confine such work to a certain portion of the shop in which the repairing operations are carried out. Spray booths or hoods only, in conjunction with suitable exhaust fans, will, to a large extent, overcome the objections of spray painting in a shop where other operations are carried on.

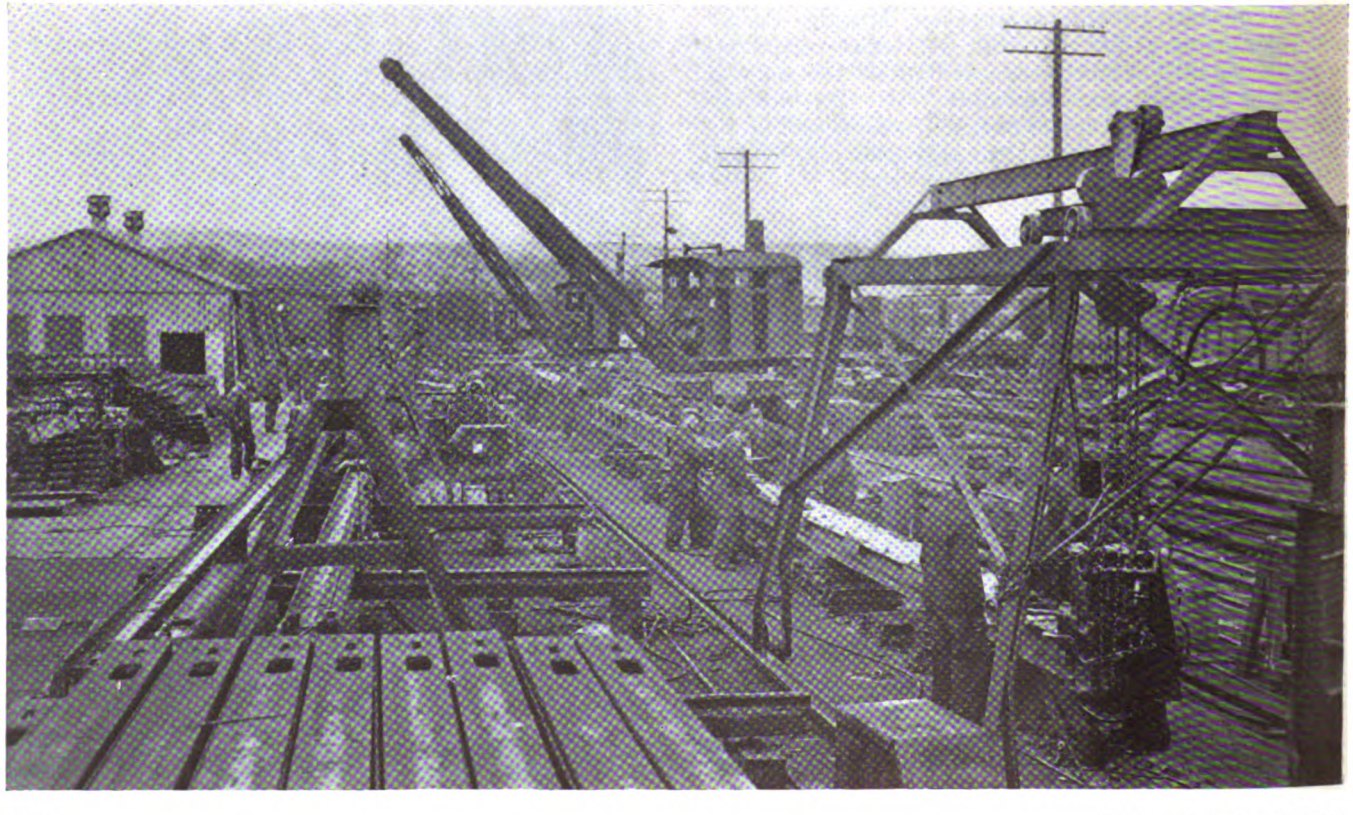
High Cycle-Frequency Equipment — Hi-cycle electric drills and reamers are coming into use more and more, and consideration should be given to installing high cycle frequency equipment with suitable outlets along the tracks to allow maximum flexibility in their adaptation. This is especially important where there is considerable steel work to be handled. The high-cycle equipment is generally considered far more efficient and practical than air-driven tools. However, where it is as yet impractical to install such electric-driven equipment, it has been found that rotary air motors give very good results. Some consider the latter to be more efficient and less expensive to maintain than toggle-type air motors.

Gas-Cutting Equipment—In order to get away from the expense of handling acetylene and oxygen in the shops, it is well to give consideration to a central distributing plant. The shop should be adequately piped and have outlets suitably located to reduce to a minimum the amount of hose required by operators of cutting outfits.

Welding Equipment—There is little need to emphasize the growing importance of welding and how costs can be radically cut by its use. However, there are several things to be considered in its application. For example, (a) the power supply should be designed not only for present needs but also for future demands; (b) outlets should be placed in frequent and suitable locations throughout the shop; (c) flexible jigs should be constructed so that most of the welding can be positioned. There are two types of welding machines, viz., alternating current (transformer type) and direct current (motor generator type). Both have their respective merits and these should be weighed before any decision is made. Besides arc-welding machines, there are the several kinds of resistance-welding machines. For light-gage material these have been found to be very satisfactory.

Tractors and Lift Trucks—These are practically indispensable. The latter are particularly responsible for the reduction in cost of handling material on skids or platforms and the moving of mounted wheels to and from wheel shop. The success of the repair or production line is dependent upon the continuous flow of material and supplies. With efficient tractor service go substantial savings.

For such a broad subject, much remains to be written. No mention has been made of heavy equipment such as punch presses, straightening presses, coping machines,



etc., which are essential to every well-organized plant. Suffice it to say that railroads in general are alive to the fact that an economical and efficient shop is one of the foundation stones of a successful system.

The report was signed by Chairman J. A. Deppe, superintendent car department, Chicago, Milwaukee, St. Paul & Pacific; J. H. Gimpel, assistant superintendent car department, Wabash; M. F. Covert, general superintendent of equipment, General American Transportation Corporation; H. S. Keppelman, superintendent car department, Reading, and P. B. Rogers, shop superintendent, Atchison, Topeka & Santa Fe.

(The committee report was accepted without discussion.)

Freight- and Passenger-Car Construction

Suggestions for improvements in rules and standards offered to Mechanical Division

Due to existing conditions on the railroads, your committee has not held a meeting. I have, however, asked the members for recommendations to submit to the general committee for review and the following suggestions are submitted for consideration:

Passenger and Freight Equipment

(1) Some railroads and private car lines are using 1½-in. steam train line; this is inadequate, especially on head-end cars. Certain railroads use the steam-jet air-conditioning system which requires steam to operate and it is felt that action should be taken to have all cars operating in interchange, equipped with a 2-in. line or larger.

(2) Elimination of noise due to buffer stems on passenger cars. At the present time we do not have anything to offer as a remedy, other than to keep them shimmed snugly to eliminate all play possible.

(3) Overhead water tanks should be provided with standard connections and applied so that tanks can be filled from either side, thus to avoid crawling under car.

(4) It is recommended that passenger-car journal boxes be cast with a well or recess on top of the box to which a forged plate can be applied to eliminate wear on top of the box brought about by foot of equalizer.

(5) It is recommended that metal ladders be used on all freight cars, new or rebuilt, and attached to the car at the top above the loading line and at the bottom so that the ladder can be readily removed without entering car.

(6) It is suggested that consideration be given to periodic annealing of the U-shape cast-steel side frames.

(7) It is found that the side walls on Type-E couplers are being kicked out and broken due to insufficient clearance for tail of knuckle. The coupler committee a few years ago increased the clearance, but did not provide enough, with the result that we are still having broken side walls.

(8) Interchange Rule 18, Supplement No. 2, shows certain revisions in regard to condemning couplers on account of cracked side walls due to the knuckle striking and breaking same. I took exception to this defect when it was presented by the coupler committee in 1932 or 1933, and am still of the same opinion that the rule is not yet right even as revised. I still feel that couplers are being condemned unnecessarily and railroads as well as private car owners are paying for couplers that should never be removed from cars, and the same railroads are taking advantage just because the rules permit them to do it; in fact, they are specializing on this defect and I do not believe that it can be shown that a coupler has ever failed due to this defect. I know that the largest railroads in the country are not removing couplers for this defect and they have been running for years with cracked side walls, and it has now reached a point where federal inspectors are reporting as broken all couplers which the rule permits them to report.

(9) It is believed that many hot boxes on freight cars could be overcome if a longitudinal rib were cast inside of the box one inch below the center line of the journal; this will prevent the dope from rolling and the box cannot be packed too high.

(10) It has been suggested that consideration be given to extension of spring plankless trucks.

(11) Another suggestion has been made that center plates be welded in place in order to overcome the many loose center plates we are having.

It is also recommended that welding of many other parts where bolts and rivets are now used be encouraged in order to reduce maintenance cost as well as reducing weight.

(12) Where bolts are now used and it is not practical to weld, it is suggested that rivets be used.

The report was signed by the committee consisting of Chairman J. McMullen, superintendent car department, Erie; C. Claudy, master car builder, Grand Trunk Western; W. A. Bender, master car builder, Alton; J. S. Acworth, supervisor of equipment, General American Transportation Corporation, and J. E. Keegan, chief car inspector, Pennsylvania.

Discussion

In discussing Item 1 of the report, the fact was developed that a number of roads have standardized on 2½-in. steam train lines which show definite advantages for long trains and head end equipment, especially that operating in northern climates. The idea of making this size mandatory, however, was opposed and a motion passed that passenger-train cars for interchange service have train lines and connectors not less than 2 in.

Regarding Item 2 the point was made that coil-spring buffer-stem snubbers seem to be giving good results, especially when the Alemite method of greasing the buffer faces is employed. Adequate lubrication also tends to enable the buffers to slide more readily with respect to each other under the heavy pressures utilized with modern buffer springs. Tight-lock couplers were also mentioned as a positive source of reducing noise.

Regarding Item 7, one member mentioned one instance in which 39 couplers were removed within a comparatively short period at a car inspection point for cracked side walls. Another member stated that if the charge for this defect were eliminated, there wouldn't be one coupler changed in a year for this cause. The motion was seconded and carried that Items 1, 3, 4, 5, 7, 8 and 9 be referred to the Association of American Railroads, Mechanical Division, for consideration and that Items 2, 10, 11 and 12 be called to the attention of the individual railroads for such action as might be deemed desirable. Item No. 6 was referred back to the committee for further study and report at the next meeting.



J. C. Lewis, President

Second annual meeting of Fuel and Traveling Engineers' Association—Program dealing with locomotive design, fuel economy, locomotive and train operation, fuel preparation and firing practice stimulates lively discussions

Locomotive Supervisors Discuss

Fuel and Operating Problems



J. R. Jackson, Vice-President



G. M. Boh, Vice-President



A. A. Raymond, Vice-President



T. Duff Smith, Secretary-Treasurer

At the second annual meeting of the Railway Fuel and Traveling Engineers' Association held at the Hotel Sherman, Chicago, on September 27 and 28, four sessions were devoted to a program of individual papers and committee reports dealing with various aspects of fuel economy and various phases of modern high-speed train operation which are of constantly growing importance. The convention was called to order on Tuesday morning by the president, J. C. Lewis, road foreman of engines, Richmond, Fredericksburg & Potomac, with a registered attendance of about 150, of which over 100 were railroad men.

Interest and attendance were sustained through three sessions on the first day. The morning session was devoted to fuel economy and utilization of locomotives. Three papers on fuel economy were prepared under the general chairmanship of Robert Collett. Two dealing with the part of the engineer and the enginehouse foreman, respectively, in fuel economy were individual papers, and the third dealing with the part of the fuel supervisor and traveling engineer was prepared by a committee. A part of the afternoon session was devoted to two papers prepared by the Committee on Fuel Records and Statistics under the chairmanship of E. E. Ramey. One of these discusses the relative value of quantity vs. cost statistics of fuel consumption and the other deals with the place of the fuel supervisor in railroad operation. The evening session was devoted to the discussion of firing practice, both oil and coal. Wednesday's session was given over to the presentation of two papers on air-brake subjects. That dealing with

the No. 8ET locomotive brake equipment and its relationship to train handling will be abstracted in a later issue.

Addresses were delivered during the convention by J. M. Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, by Dr. Roy V. Wright, editor, *Railway Mechanical Engineer,* and by Charles F. Richardson, president, West Kentucky Coal Company, a past president of the association. Mr. Richardson called attention to the community of interests between the railroads and the coal miners in trying to bring about a more equitable situation with respect to the marketing of coal and oil, particularly with reference to the unequal incidence of taxation on the railroads and the pipe lines.

Mr. Hall's Address

In his brief address, Mr. Hall stressed the part that traveling engineers could well take in the matter of educating enginemen on safe water level, especially on modern locomotives some of which have extremely long crown sheets with the bottom gage cock and lowest reading of water glasses set at or close to the minimum height above the highest part of crown sheet permitted by the rules—3 in. On locomotives thus equipped especial attention should be called to the safe water-level markings on the back head for the various grades encountered since a comparatively small change in the grade may endanger the crown sheet if only the minimum water level shown by the bottom gage cock and water glasses is carried. Proper use of and attention to the boiler feeding devices and low-water alarms was also emphasized.

Mr. Hall said that, except in rare cases of defects or failures of a type that could not be foreseen, there should never be a low-water boiler failure and that he hoped that all traveling engineers fully recognized it to be an important part of their duties to see that enginemen closely observed the indications of gage cocks and water glasses and lived up to instructions concerning the minimum water level that could safely be carried under various conditions of operation and the procedure to be followed in the event of sounding of the low-water-alarm whistle.

In connection with the latter Mr. Hall said that there seemed to be a misunderstanding among some enginemen as to the time between the sounding of the alarm and the occurrence of a dangerous condition. Some enginemen that he had heard of were of the opinion that they had 15 min. following the sounding of the alarm before an unsafe condition would arise. He emphasized the fact that should the water feed fail when the water level in the boiler was 3 in. above the highest part of crown sheet, even with the locomotive working considerably below maximum capacity, the crown sheet would begin to be exposed in a fraction of this time, that the sounding of the alarm was a signal of real and immediate danger, and that appropriate action should be taken at once in order to avoid disaster.

Mr. Hall said that it was well recognized that traveling engineers generally had a larger territory than one man could adequately handle and the nature and volume of work assigned to them was often such as to preclude the giving of as close contact and personal supervision as could be desired, but that every possible effort should be put forth to instruct the enginemen in safe practices and to see that the recommended practices were observed.

Supplementing his remark that, with the possible exception of very rare instances, there should never be a lower-water failure Mr. Hall cited the experiences of his Bureau in finding contributing causes, or defects of the boiler or appurtenances, the existence of which may have had some bearing on the accidents. He said that in the earlier years in which the locomotive inspection law was effective contributing defects were found in one-half or more of the crown-sheet accidents investigated, that in later years there had been a sharp decrease in this proportion, and that for the last full fiscal year in which statistics are available (1937-1938) no contributing causes were found in the investigations of the five accidents that occurred in that year.

He compared the five crown-sheet accidents due to low water that occurred last year with the 92 accidents of the same character in the fiscal year 1911-1912 and stated further that in that year there was a total of 856 accidents, 91 persons killed, and 1,005 injured as a result of failures of boilers and their appurtenances, whereas in the year just closed (1937-1938) there was a total of 59 accidents from these causes, with 5 persons killed and 59 injured.

In connection with accidents resulting from failures of locomotive parts other than boilers and their appurtenances, generally called machinery accidents, Mr. Hall stated that 839 accidents occurred in the year 1922-1923. These caused 25 deaths and 966 injuries, whereas in the year 1937-1938 the total number of such accidents was 149, with 2 persons killed and 157 injured.

Dr. Wright's Address

Dr. Wright spoke of several aspects of the work of the traveling engineers and other supervisors of locomotive operation which have a direct bearing on public relations as well as on employee relations. In this category are the effect of the work of the enginemen in train handling on the shippers' desires for improved schedules and for the prevention of loss and damage to freight, and the control which the enginemen exercise over the smoke nuisance. With respect to the latter he cited the outstanding results which have been attained in the reduction of railroad smoke in Hudson County, N. J., by the Railroad Smoke Association, an organization of local railroad men under the direction of the Department of Smoke Regulation of the county, and pointed out that too little attention is given to a clean job of firing outside of such restricted areas, with a consequent waste of fuel as well as unfavorable public reaction.

Dr. Wright also referred to the opportunity which the various supervisors of locomotive operation have for improving relationships between the men in the cab and the managements. They are in a position to interpret the needs and objectives of the management to the men in an understandable way and, by the same token, can also bring to the attention of the management an understanding of the views as well as the suggestions of the men.

Election of Officers

Officers and committee members for the year 1938-39 were elected as follows: President, John R. Jackson, engineer of tests, Missouri Pacific. Vice-presidents: G. M. Boh, district road foreman of engines, Erie; W. H. Davies, supervisor air brakes, Wabash; A. A. Raymond, superintendent fuel and locomotive performance, New York Central. Executive Committee, for two years: M. F. Brown, fuel supervisor, Northern Pacific; S. A. Dickson, fuel supervisor, Alton; L. E. Dix, fuel supervisor, Texas & Pacific; J. J. Kane, road foreman of engines, Lehigh Valley. For one year: E. E. Ramey, fuel engineer, Baltimore & Ohio; W. C. Shove, general road foreman engines, New York, New Haven & Hart-

ford; R. S. Twogood, assistant engineer, Southern Pacific; E. F. Allard, general fuel supervisor, Chicago & North Western. T. Duff Smith is secretary-treasurer. On the advisory committee are E. E. Chapman, mechanical assistant, Atchison, Topeka & Santa Fe; J. N. Clark, Southern Pacific; R. Collett, fuel agent, St. Louis-San Francisco; M. A. Daly, fuel supervisor, Northern Pacific; J. E. Davenport, assistant chief engineer motive power and rolling stock, New York Central System; T. C. Hudson, general superintendent, Canadian National; G. A. Kell, Canadian National; J. M. Nicholson, mechanical superintendent, Atchison, Topeka & Santa Fe; A. T. Pfeiffer, road foreman engines, New York Central; F. P. Roesch, vice-president, Standard Stoker Company; T. Duff Smith, and W. J. Tapp, fuel supervisor, Denver & Rio Grande Western.

Abstracts of the papers and reports, accompanied by summaries of the discussions, follow.

Fuel Quantity vs. Cost per Service Unit

Quantity statistics basic but cost figures have supplementary value

Shall fuel performance records be stated in terms of pounds of coal per 1,000 gross ton-miles, passenger-train car mile and yard-engine hour, or in terms of cost of fuel in cents per 1,000 gross ton-miles? This question may be boiled down to fuel quantity per service unit versus fuel cost per service unit, and it appears that the significant inferences to be drawn from the question are:

1—That the best performance in pounds of fuel per service unit may not be the lowest cost performance.

2—That the lowest cost performance is the proper goal for the efforts of the railroad operating personnel.

3—That where there are price differentials on the various grades or sizes of coal the grade that produces the lowest cost performance should be used.

4—That any adjustments that may be necessary in the equipment of the locomotives to make the use of lower-cost grades of coal practicable should be made.

There can be no argument against the use of the grade of coal that produces the lowest cost per service unit if it will prove practicable from the standpoint of operating service requirements and not cost more indirectly or in other directions than is saved on the locomotives. These angles are subject to demonstration from study of test results on the locomotives and analysis of incidental costs, such as for extra handling of the coal, and servicing and maintenance of the locomotives. It will have to be recognized however that opportunities for reducing costs through differential prices on grades of coal are very greatly restricted if not entirely eliminated when a uniform price for "coal for railroad fuel" is enforced—as it has been during periods of operation under coal price codes.

The local employees and the officers in charge of local operations have no control over the qualities and the grades of coal purchased, nor over the prices paid. Their effectiveness in fuel performance can be measured only by the quantities they use in the production of unit service results. They are properly responsible for, and particularly interested in, the record of the unit quantities. They need and want this form of statement of results, and are only incidentally concerned with the cost figures, which should, however, be given them as a matter of general interest.

On the other hand the higher general officers in charge of the management of the railroad, and responsible for the financial results of the operation as a whole, do have some measure of control over the qualities and the grades of coal purchased and some degree of choice, within the limits imposed by the general level of prices, of paying more for better qualities or grades, or less for the less desirable qualities and grades of coal. They are principally interested in the final result stated in terms of cost per unit of service and they need that form of report in addition to the report of quantities used per unit of service.

The views expressed in the preceding paragraphs are particularly applicable to comparisons of performance made over so short a period of time that no change in the general level of prices has taken place. It is obvious that if a difference exists in the general level of coal prices as between two periods that are being compared, as for example, this year vs. last year, the comparisons of cost per unit of service would be entirely meaningless as to relative efficiency of performance without a corresponding statement of the prices for the two periods.

The statistical reports of practically any railroad will disclose marked variations in the average price of coal as charged into the operating expenses as between succeeding years and even as between succeeding months of the same year. This may be due to one or more of a number of varying conditions, such as variation in the proportionate use of different kinds of coal purchased at different prices, or variation in the price of the same kind of coal as between different mines, and variation in the proportionate use of coal from the different mines, or the signing of a new miners' wage agreement, etc. The point here made is that the average price of coal on any railroad is a quantity that varies most erratically due to many factors entirely beyond the control of the personnel responsible for fuel performance, frequently beyond the control of the management as well, and usually without any relation whatever to the quality or grades of the coal or to any feature or condition whatever in any way connected with railroad operation.

The principal purpose and utility of statistical reports of performance is to disclose the trend of the performance, i.e., to show whether or not improvement is being made and at the same time to show, in so far as may be, the factors responsible for the trend. While we believe that the cost data are instructive and well worth the slight additional work required to produce them, they should be used to supplement but not to replace the more stable and fundamental index of performance based upon quantities of coal consumed per unit of service.

There is no intention to deny the value of cost of performance comparisons covering special situations or conditions. For example, the introduction of the Diesel-electric locomotive creates a special situation in connection with which the statement of performance on a cost basis is logically required. This feature is, of course, not particularly important at this time on many railroads for the reason that Diesel-electric locomotives are as yet used only to a limited extent, but the present trend in this direction indicates that in a comparatively

short time their use will materially affect the fuel costs on some of our railroads.

Another rather special situation in which the statistical statement of the cost of fuel per unit of service would undoubtedly be of considerable value is the case of the several railroads that operate in the west and southwest using both coal and fuel oil in their steam locomotives, since it would give the higher officials of those railroads a direct comparative cost per unit of service for both the coal and the oil, assuming, of course, that these railroads would have the quantity of fuel consumed per unit of service worked separately for their oil-burning and their coal-burning territories.

This report was signed by a committee consisting of W. J. Overmire, N. Y. C.; E. E. Ramey, B. & O., and E. G. Sander, A. T. & S. F.

The Enginehouse Foreman and Fuel Economy

Firebuilding, air and steam leaks in the house and crew cooperation his responsibility

By R. K. Thornley
Enginehouse Foreman, Wabash

The enginehouse foreman's success in fuel economy depends on the effective use of personal attributed in business. Good judgment, common sense, honesty, a willingness to learn, the ability to use the experience and good advice of others, are all very important factors towards conservation of fuel.

The amount of fuel consumed in and around the roundhouse that does not produce revenue service direct is a responsibility of the enginehouse foreman, as the fuel is burnt under his direct control. If the facilities involved cause fuel to be burnt unnecessarily, a report of the condition should be made to his superior with a suggestion as to what should be done to make an improvement.

Fire Building

As a rule the lowest paid class of labor employed in the roundhouse is engaged in burning the largest per cent of fuel that is concerned in preparatory service; in a great many instances they require the most supervision as they must be instructed how to do their work. The most economical method can only be developed by the enginehouse foreman making a careful study of the operation so that he can properly instruct those doing the work, then follow the matter up from time to time to see that his instructions are being complied with.

In building fires, if dense, black smoke is emitted from the stack of which the density is greater than grade No. 2 on the Ringelmann chart, the method of fire building is incorrect or conditions or facilities are not equal to the correct method. When unburnt gases are permitted to pass out through the flues and stack as dense black smoke, more or less soot will always lodge against the firebox sheets and the interior of the flues, forming an insulation which is said to be five times more effective than the best asbestos of equal thickness. When this occurs the process of the heat passing to the water in the boiler is retarded and a longer period is required to raise steam pressure sufficient to handle the locomotive out of the house. This means that fuel has been consumed unnecessarily in preparatory service. The soot that passes through to flues, coming in contact with any moisture that may be on the front-end netting, will cause the netting to plug up, retarding the draft on the fire, resulting in fuel being consumed unnecessarily in both preparatory and revenue service, and often is responsible for steam failure. Dense black smoke is a waste of fuel as well as not to the best interest of the community in which the enginehouse is located. The practice of building fires by which the steam pressure can be raised to 100 lb. in the quickest time we find is the most economical.

Air leaks in shop pipe lines are very expensive regardless of whether furnished by an electric or steam driven compressor, as the results of the leaks are measured in dollars and cents, matter not whether paid out for electricity or fuel. Compressed air is the most expensive energy we have in and about enginehouses as the average cost is 11 cents per 1,000 cu. ft. The cost of air and steam leaks are shown in the tables.

Cost of Leaks in Air Piping

Size of leak, Dia. in in.	Number of cu. ft. per month at 75 lb. pressure	Total cost of waste per month, 11¢ per 1,000 cu. ft.
1/2	13,468,000	$1,481.44
3/8	7,558,500	831.44
1/4	3,336,990	370.37
1/8	824,570	90.70
1/16	213,000	23.43
1/32	52,910	5.82

Cost of Steam Leaks

Size of leak, Dia. in in.	Pounds wasted per month at 160 lb. pressure	Total cost of waste per month at 65¢ per 1,000 lb.
1/2	1,219,280	$792.53
3/8	684,290	444.79
1/4	304,820	198.13
1/8	74,650	48.52
1/16	19,280	12.53
1/32	4,790	3.11

On railroads having water treating plants or any other system of water treatment, the enginehouse foreman should familiarize himself as to the operation so he shall know that it is being operated correctly. Water treatment is a very important factor towards fuel conservation. Sometime ago in an address before the American Chemical Society it was said: "In the United States the average thickness of locomotive boiler scale is 1/16 in.; this means a loss of at least 13 per cent in fuel efficiency." It is recognized that a correct system of water treatment correctly used will eliminate scale formation.

Create a Cooperative Spirit

The largest per cent of the fuel is consumed by the locomotive away from the roundhouse, while in charge of the enginemen. However, the enginehouse foreman is charged with the responsibility of seeing that the locomotive has been prepared properly so as to be able to render service economically as well as successfully. To

bring about this condition it is necessary that the enginehouse foreman have the full cooperation of the enginemen; they are the ones who are operating the locomotives burning the fuel and producing the kind of service your railroad has to offer to the public.

The enginehouse foreman should realize that he must take the initiative to create a cooperative spirit by knowing that the locomotive has been properly conditioned before being dispatched, in the way of flues, clean arch, grates and rigging in good condition, front end free from air leaks, interior of cab clean, and all work reported by inbound crew to be completed when consistent to do so. When the enginemen see that the enginehouse foreman is making an effort to have work done to make their jobs a better one, they will cooperate with him or at least the largest per cent of them will, and in turn they will give the necessary information that must be had in making analysis of certain operating conditions. Cooperation when it is sound and enduring must be absolutely voluntary.

After the fuel has been burned a correct system of accounting should be made so that when making a cost study of the fuel the figures shall reflect a true condition. When fuel is burned in yard offices, stations, switchmen's and crossing watchmen's shanties and cabins, cabooses, maintenance of way department service cars, drying sand, enginehouse stoves, or for any purpose other than actual transportation, the charge should be made against the account provided to cover the cost of the particular operation and should not be charged to transportation. In charging fuel to transportation, a distribution between the three classes, namely: switch, freight and passenger should be made in order that the figures shall reflect a true cost.

Discussion

Fire building at terminals came in for most of the comment following the presentation of this paper. Some question was raised as to the ability to fire up locomotives without exceeding the Ringelmann No. 2 smoke. It was generally admitted that under the most favorable conditions such a result could be obtained, but if the job had to be hurried it could not be done.

The tables of air and steam leaks which were included in the paper are posted in blue-print form in the enginehouse of the Wabash where they serve to advise all enginehouse employees of the cubic feet of air or pounds of steam lost through leaks of various sizes and the cost of such leaks in dollars per month. They keep all employees on the alert to note and report such leaks as quickly as they develop.

The Relation of Enginemen to Fuel Economy

Begins with the selection of firemen adapted to the job

By Harley Finberg
Locomotive Engineman, Northern Pacific

The relationship of the engineer and fireman to fuel economy is an alliance that should be originated in the student fireman, then augmented by teaching and experience until the act of saving fuel becomes so natural that it is accomplished methodically without apparent effort. Railway business conditions today are such that, because of long service periods, the majority of enginemen have acquired this relationship to a very lucrative extent. There are a few exceptions, of course, those men not adapted to the vocation who have the initiative but lack the ability to acquire this relationship, in consequence of which their life work becomes a continuation of unpleasantness and hardship, while their employer suffers from the inferior performance in many ways and ultimately in an out-of-pocket loss. Some railroads are correcting this by discontinuing the employment of student firemen who fail to show proper adaption to the work. While this may seem unjust to the man involved at the time, he is really fortunate, as he must seek other employment which may give him more success and happiness.

The railroads face a real task in this matter as the average ages of both engineers and firemen are such that they must all be replaced in a comparatively short period of time.

During the last score of years the engineer and fireman have been assisted appreciably in their labors and efforts to conserve fuel by an outstanding improvement in fuel preparation. Today railway fuel is a cleaner product than can usually be obtained for domestic use, while formerly it was a regular practice for firemen to throw out large size iron pirites and other impurities from the fuel in order to reduce as much as possible steaming and fire maintenance difficulties. No doubt the demand for and success of the finer types of grates installed in locomotives during recent years was to some extent the result of cleaner fuel, as the coarser types of grates were adapted to burning coal containing excessive impurities, but created large ashpan losses, inability to control fires, etc., when well prepared fuel was furnished.

The knowledge and cooperation of those responsible for locomotive conditions affecting performance, particularly steaming, is very gratifying, as all locomotives today steam freely except when occasionally prevented by unavoidable circumstances which are given prompt attention. This is a revolution from former times when some engines failed to steam properly from shopping to shopping, but caused no one concern except the engineer and fireman. To encourage enginemen in studying out and reporting locomotive defects they should be furnished correct information regarding the accuracy and inaccuracy of their reports.

The continued improvements made on locomotives is very encouraging to fuel conservation, especially on the newly designed power, but in most cases the demands made on the old power under present operating conditions are such that there is no opportunity for additional economy by enginemen except the elimination of unnecessary losses. The performance of old power is remarkable considering the increases that have been made in tonnage and speed, but there seems to be no reserve for further increases, which should not be expected unless additional devices for efficiency can still be obtained for this old power.

In order to retain our gains, there should be no let up in the efforts of this association to create interest as

it has and is doing, and the railroads should not cease to do their part both in keeping this association animated and by following its suggestions and recommendations, for, if they did otherwise, things would quickly slip backwards toward the old starting point.

Discussion

That the making of a good engineman starts with the student fireman was emphasized in the discussion and it was pointed out that on some railroads the applications of firemen are not finally approved until the end of a 30-day student period. The importance of engineers and firemen working together was also referred to several times and the fact that, with the exceedingly tight schedules which now prevail in passenger service, it is necessary for the fireman to work with the engineer rather than the reverse, since there is little opportunity for the engineman to favor the fireman as used to be the case.

Where extended locomotive runs prevail, a spirit of cooperation between the crews of adjoining divisions becomes necessary in order that fires may be turned over at the end of each division in good condition for the outgoing crew. Attention was called to the discouragement to which enginemen and firemen are subjected after they have worked together to make the time economically when other members of the train crew and the station employees lose a minute or two or three in handling baggage or express. The engine crew are expected to make up this time, which they cannot do without a discouraging setback in fuel economy.

How the Fuel Supervisor and Traveling Engineer Promote Fuel Economy

Importance of clean coal and correct practices of sizing, loading and handling stressed

Clean Coal from the Mine

On roads where coal is used as the basic fuel, one of the fuel supervisor's outstanding economy factors is that of proper preparation at the mines. During the process of hauling one million tons of coal to its destination for use on locomotives, which in many instances may involve several hundred miles, and which, for example, was purchased on a specification basis of not to exceed 9 per cent ash, should the preparation be neglected to the extent of allowing enough impurities such as are usually known as binder, bone, shale, etc., to slip and run the ash up to say 10 per cent, an additional 10,000 tons of waste matter would be hauled to the point of consumption, this would be equivalent to 200 50-ton cars, being hauled by locomotives consuming other fuel to do the job.

Other items worthy of frequent attention at the mines, are the condition of hopper doors on empty cars arriving for loading; also the condition of cars as to cleanliness, which includes the removal of any dirt or other refuse matter such as tramp iron, and the removal of any ice or snow accumulation. Frozen coal mixed with ice or snow in the bottom of the cars will increase the cost of handling, and the breakage and pulverization at the time of unloading. When loading, the cars should only be filled to the point where none will fall off or be lost in transit or when shifting cars in yard operations.

At mines which produce the softer texture coals, installation of adjustable loading booms will aid materially in the reduction of fines which are due to rough usage. The installation of magnets for the removal of lost mine tools and any other tramp iron passing through with the coal, will usually pay all of the costs connected with this venture within a short time. A pound of this type of material, if placed on the tender of a stoker-fired locomotive may cause several tons of coal to be sacrificed in connection with failures, delays to trains, etc.

Sizing and Preventing Undue Breakage

Breaking or crushing the coal at the mines to the maximum sizes desired for locomotive use will produce less objectionable fines than would result if done at any future time, as the coal coming up from the mine is usually warm and will break down easily without excessive shattering or pulverizing. This will also make it possible to remove the major portion of the incombustible matter while the coal is passing over the picking tables. A better mixture will also be retained while the coal is passing through the various moves of handling.

With the ordinary run-of-mine coal, should the matter of sizing be neglected, separation will increase with each handling, resulting in part of the locomotives receiving the equivalent of screened coal and others a full tank of fines. Increased steam consumption accompanied by excessive wear and tear to stoker, and uneven firing, will prevail in the former and increased stack loss, possible steam trouble and stoppage or honeycombing of flues, with the latter, under certain conditions at high firing rates.

The practice of keeping dumping pits, storage bins or tubs partially filled, will assist materially in the handling of softer texture coals at coaling stations. Shorting or not fully coaling tenders as opportunity presents, will keep coal on the tender moving and reduce packing and air slacking.

Distribution

Where conditions and facilities permit, it may be possible to work out a distribution schedule that will provide for the use of the higher-ash coals on short runs where consumption rates are lowest. A high ash coal that would not interfere on a yard engine consuming three to four tons during an eight-hour trick, probably would present some difficulties on extended locomotive runs involving heavy and fast service with attendant high firing rates, particularly in the cleaning of ashpans and fireboxes of the ash accumulation at intermediate points enroute.

At coaling stations which are equipped with more than one storage and dump track, a more economical mixture may sometimes be obtained by blending the various textures and grades of coal.

Consistent practices should be worked out with the forces at all terminals and outlying points in the direction of a uniform method of handling the work of dumping, firing up and holding engines under fire when necessary. The latter item is very essential on Sundays, holidays, etc. Various estimates ranging from ten to twenty-five per cent have been made by authorities in regard to the amount of coal consumed at and around terminals, in comparison to the total consumption in revenue service, there-

by proving the importance of this factor to possible further fuel savings.

The Road Foreman a Salesman

In addition to his wide practical experience concerning locomotives, and their operation, and to fuel as it fits into the railroad picture from the viewpoint of expense and other angles the road foreman of engines must, in order to obtain consistent and lasting results, be a salesman of no mean ability and versatile enough to attract and hold the interest of the varied types of men who make up the personnel of his enginemen.

Best results can only be expected from men who have at least a fairly good working knowledge of the power plant, in the cab of which they spend a substantial portion of their lives. The program may be started by asking each man a few of the simpler questions which are oft times overlooked entirely, such as, how many and what are the valve and cylinder events for each complete revolution of the driving wheels; the purpose of lap, lead, cutoff and expansion; the care and attention necessary in order to insure good performance from the auxiliary appliances; parts which make up the motion work; gradually working up to questions and discussions relating to the locating of pounds and blows; also helping out with the answers whenever it becomes necessary, as this interest and assistance will have its natural reaction with the men and encourage them in seeking further knowledge for themselves.

The second step, that of the operation, will include all the best recommended practices, both old and new, that will apply to each class of locomotive and the service that it is engaged in, which should lead up to an increased output and efficiency over that of past performance. Some of its angles will shape up in the form of discussions relating to combustion, good firing practices, condensation, superheat, lubrication, boiler feeding, working steam expansively, and many others.

Locomotive operation is an outstanding subject with the road foreman on roads using oil burning locomotives, due to the fuel losses which can so rapidly accumulate in this type of service. Some of the items are, the general method of firing; proper sanding at regular intervals; condition of the brick work; lost motion to the firing valve rigging; and most particularly to the way that the water is carried in the boiler. It is very easy to overpump an oil-burning locomotive on account of not affecting the steam pressure, should any be lost through poor management.

The quality of the results obtained from the foregoing will be most clearly expressed in the next factor which is a natural by-product of the first two, namely, that of clear and intelligent work reports by enginemen. This item has an outstanding influence on enginehouse expense and efficiency, fuel consumption, operation and many others, and it also provides the road foreman with a reliable index as to the general condition of the power on his assignment.

The Road Foreman an Operating Officer

The road foreman also has a very close contact with the operating department, and his regular duties bring him to a point of actual touch with the daily operation. He usually can accomplish something in the direction of fuel saving by giving some attention and offering some advice on such items as the selection and assignment of the proper size and type of locomotive for each job or run; reducing to a minimum the number of locomotives under fire at terminals that will meet requirements; the balancing of freight-train tonnage as far as possible and still meet schedule requirements, having in mind that the running of one or more trains with saturated tonnage in order to make up for several trains which have been operated with extremely light tonnage usually turns out a poor investment, particularly should this train interfere with and delay other trains.

Duplication of stops by freight trains to do work at the same points on road should be checked frequently and kept at a minimum of requirements that will protect car service.

A study of the location of wayside signals in their relation to trains making stops and starts, when they are in stop or proceed position; keeping work trains out of the way of heavy through trains, and limiting the number of track restrictions or slow orders in force for a given period of time on each district, should benefit the operation and react favorably on the fuel performance on the district concerned.

This paper was prepared by a committee consisting of George M. Boh, Erie, chairman; L. E. Dix, T. & P., A. S. Headley, B. & O., and L. D. Burdell, Erie.



Braking of High-Speed Passenger Equipment

The brakes for this service are still in the development stage

Brakes for controlling high-speed trains are still very much in the development stage and there are a number of phases on which development has not progressed to a point where any definite conclusions have been reached. For example, the matter of disc or drum brakes versus wheel brakes, wheel controllers or anti-sliding equipment, etc., are subjects receiving very earnest consideration at the present time.

It is unfortunate that a considerable number of truck-mounted cylinder installations have been devised so that excessive brake-cylinder pressures are required to move the brake shoes against the wheels, thereby greatly reducing the value of the individual car brake with all degrees of brake applications, as well as destroying harmony of action and distribution of brake value in trains including both the body- and the truck-mounted brake equipment. A maximum of 5 lb. pressure in the brake cylinder should be required to move the brake shoes against the wheels.

Tests show that adhesion may range from 5 per cent on a wet or frosty rail to as much as 40 per cent on a well sanded dry rail. The necessity for providing efficient sanding devices is recognized as of vital importance in connection with high-speed train braking. Sanding from the locomotive alone is not sufficient to insure a good rail condition under a long train, as each wheel cleans off some of the sand and the rail condition under the rear portion of the train is a little better than if no sand had been used.

To improve this condition sanding stations have been installed on some of the cars in several of the later high-speed trains, which operate from the control-valve during an emergency brake application. One train being built will have a sanding station in the middle of the train operated by the engineer as well as by the control valve. It would be practicable to consider such applications only to the trains which are made up of cars which operate solely in such trains and which are turned at each end of the run of such trains.

It seems impracticable to attempt to carry sufficient sand on a car to provide for all brake applications. Means must also be provided to prevent operation when not desired, such as when the train is standing, or passing over interlocking plants, etc., entailing more or less complicated mechanism which must be maintained.

In co-operation with the Pennsylvania Railroad the Westinghouse Air Brake Company carried on exhaustive tests on the Wilmington division in the latter part of 1937. Exceedingly short stops were obtained under good rail conditions and with the wheels protected with a Westinghouse device called an anti-wheel slider, and it was established that in order to insure short stops under varying rail conditions an anti-wheel slider is a very desirable device.

It is an accepted theory that the stopping distance of a passenger train should not increase at a much greater ratio than the square of the speed. In this connection, it should be noted that heat is generated whenever the speed of the train is reduced through brake action.

Service or emergency brake applications, braking ratios, in other words, brake-shoe pressures, modify the accumulation of heat, but heat, as such, is inevitably produced whenever the train is stopped. One advantage of light-weight trains not always considered lies in the reduction of heat generated during brake applications. Evidently, in stopping a train from a given speed, the lighter the wheel load the lesser the problem of dissipating the heat created during the stop.

Varying Braking Force During Stops

To accomplish a stop in the shortest distance possible it is necessary to use high braking ratios during the early portion of the stop and to reduce the braking force as the speed reduces to avoid sliding wheels in the lower speed zones. Some of the modern high-speed train brakes are designed to develop as high as 250 per cent braking force at speeds above 65 miles per hour, and automatically to reduce this in two or three steps to about 100 per cent at speeds below 20 miles per hour. This insures a high rate of retardation in the higher speed zones.

In order to reduce the wide range of frictional values at different speeds, one of the brake shoe manufacturers has developed a shoe with carbon inserts, comprising about 13 per cent of the wearing surface. The carbon acts to reduce the surface temperature of the shoe and therefore increases the coefficient of friction at higher speeds without material change at the lower speeds. This makes the brake more efficient in the higher speed zones.

It is impossible to maintain at all times absolute uniformity of retardation for every brake shoe throughout a train, and in order to attempt such a condition various weight cars are in some instances braked at different braking ratios. The condition of brake shoes varies and also the condition of wheels, so that even though each shoe has a design of brake gear and a force applied to bring about as nearly as possible shoe pressures proportionate to the weight on wheels, each unit will not retard at exactly the same rate.

Power units present a more difficult problem, because excessive shoe pressures are necessary compared to shoe pressures on the average car, and which increases the difficulty of providing shoe and wheel metals which will withstand the heat generated under somewhat prolonged or frequent brake applications such as are necessary in moderate grade train operation. It is, therefore, necessary under such conditions to favor the power units in the development of shoe and wheel heat in order to prevent intolerable brake shoe and wheel damage. This, of course, necessitates an increased braking pressure upon the train to offset the underbraked weight of the power units. Under such conditions the potential speeds are governed solely by the ability to control trains within distances provided by block signal systems and the capacity of the braking elements to withstand the heat developed.

This report was presented by J. A. Burke, supervisor of air brakes, Atchison, Topeka & Santa Fe. It was also signed by H. I. Tramblie, C. B. & Q., and A. G. Mueller, air brake instructor, Chicago, Rock Island & Pacific.

Discussion

In the discussion of this paper Lawrence Wilcox of the Westinghouse Air Brake Company called attention to the fact that the objective of the entire development of braking high-speed trains is to keep stopping distances from increasing more than in proportion to the square of

the speed. He reminded the audience that much more time had been available for making earlier developments in passenger braking than has been the case in the development of brakes for the modern high-speed trains. This development has all taken place in about two years. This, he said, must be kept in mind when considering the amount yet to be done before a completely satisfactory solution of the present problem is attained.

The entire discussion stressed the importance of wheel conditions on the high-speed equipment. Brake-shoe pressures of about 12,000 lb. per wheel were stated as about the limit to which the wheel can be practicably subjected. In stopping a train from 104 miles an hour on a 1½-per cent descending grade it was pointed out that the center of the wheel tread soon begins to show red and that the band of glowing metal gradually extends until it covers nearly the width of the brake shoe and becomes the color of molten metal.

Coal-Firing Practice

Report and discussion relate largely to firing up at terminals

The following instructions (substantially those followed by an eastern railroad) should assist enginehouse forces to avoid violation of good practice.

Engines should arrive on receiving track with enough steam and water to carry them to inspection or cinder pit, whichever is first. Where inspection pits are in advance of cinder pits, engine watchman should be properly instructed in keeping fires so there will not be an undue amount of coke or green coal to be knocked into the cinder pit when the fire is cleaned or dumped.



The diagonal mirror at the left end of the New York Central periscope is of "Herculite," a special heat-resistant glass

Tenders should not be overloaded. Space around tank gates and rear of tender should be kept free from coal. Person coaling tenders should trim them before the engine moves from the coaling station, to avoid waste of coal and possible injury by falling lumps along the right-of-way or at stations.

Fires should be cleaned by the following method: Hoes to be used to pull fires from forward or flue sheet end of the firebox to the back end; then shake the dirt or clinkers through the forward grates until they are bare. It may be necessary at times to pull clinkers through the fire door. After the forward grates have been cleaned and leveled up the hoe should then be used to shove fire and coke from the back end of firebox to the forward grates. The back grates then should be cleaned of dirt and cinders as were the forward grates. Then pull the fire back over the entire grate surface. Do not build the back end of fires any heavier than other parts of the fire on the cinder pit. Shut off blower before safety valve opens.

After the fire has been cleaned and the engine put in the house, and it is found that the engine will not be needed or a mechanical defect develops which will cause it to lay in for several hours, fire should be allowed to die. A metal tag placed on the fire door "LET DIE" will assist the engine watchman.

Engines arriving with a mechanical defect shall be dumped where there is a doubt about having the engine for service under 24 hours.

Ashpans should be thoroughly cleaned, particularly that portion of the pan under the mudring, and all side and end pockets, to insure full air opening to the pan.

All six-day locomotives shall be dumped upon their arrival and so kept until three hours or less of their departing time when weather and enginehouse room or other local conditions are favorable. Grates should be covered to about four inches in depth with coal slightly heavier in back corners and sides, this to stop any circulation and retain heat in the boiler. This takes moisture from the coal, the fire kindles quicker and with less black smoke. Shavings saturated with crude oil are distributed over the top of the coal as placed in the fire box and lighted from the fire door or by the use of an oil torch.

Engine watchmen shall keep fires banked to forward, back and side sheets, allowing the center to die out on all locomotives with a 44 sq. ft. or greater grate area.

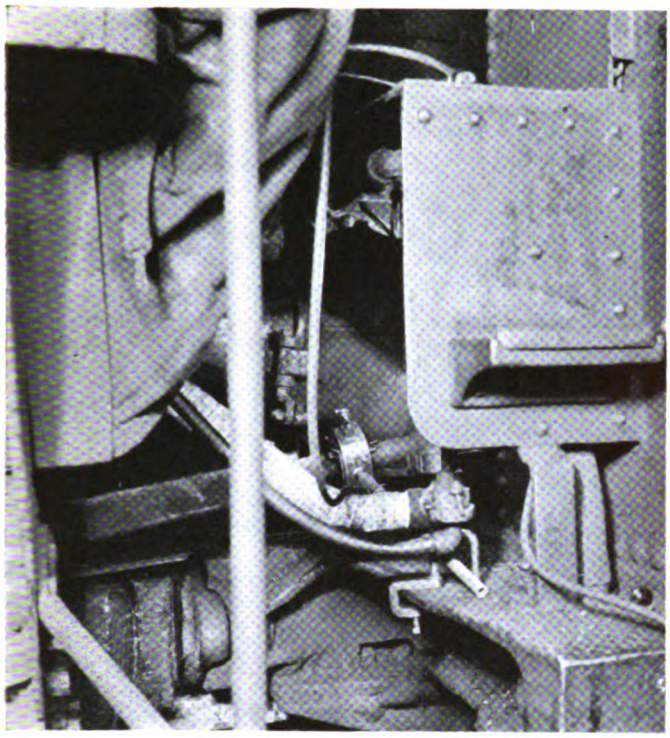
On all narrow type fireboxes the fire shall be kept banked ahead, letting two or three grates in the rear of the firebox under fire door die out. Fires banked according to the above should be pulled over the entire surface about one hour before departing time.

Engine watchman should never get steam pressure within 25 lb. of maximum except when safety valves are being tested.

Boilers should never be filled so that water is out of sight in the glass. Anyone working in the cab using



Observing the condition of the fire at the back corners with the periscope



Application of the revolution counter to the stoker drive shaft

the blower to take the gas out shall close blower before leaving the cab, and close the fire door as a protection against fires in the cab.

Don't overload tenders.
Don't allow pops to open unnecessarily.
Don't permit dirty deck or apron.
Don't throw large lumps in fire—crack them.
Don't forget "LET DIE" tag.
Don't forget fuel conservation.
Don't forget safety.

The report was signed by W. C. Shove, chairman, N. Y. N. H. & H.; M. B. Morrow, Northern Pacific; L. D. Burdell, Erie; S. M. Roth, Western Maryland; C. C. Connell, Wabash; J. J. Kane, Lehigh Valley; M. Cavanauh, C. St. P. M. & O.; H. Malette, St. L.-S. F.; W. B. Kilgore, C. & O.; J. J. Millett, Illinois Central; C. S. Mikles, N. Y. O. & W.; S. T. Reid, Michigan Central, and Wm. Small, B. & M.

Discussion

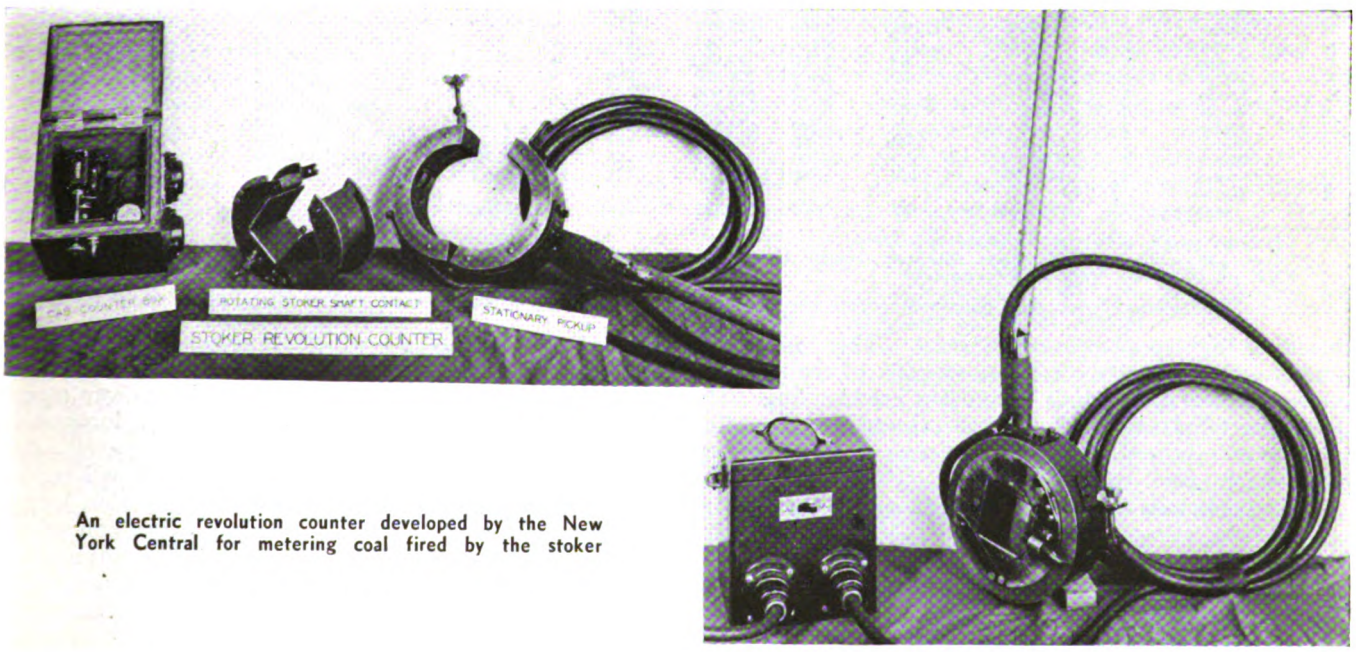
Most of the discussion following the presentation of the report on coal-firing practice dealt with methods of firing-up locomotives at terminals. Two methods were described. The first was the level method in which the grates are covered with about one scoop of coal per square foot, carefully leveled, covered evenly with shavings, and lighted all over the surface. The fire door is then left on the latch until steam pressure has been raised.

Practice on the New York Central at Chicago where smoke restrictions are severe is quite different. At this terminal the level method caused frequent smoke violations. The terminal dispatches about 100 locomotives per day from a small house. The present practice is to put in from 140 to 200 scoops of coal (an average of between two and three scoops per square foot of grate), throwing it against the side sheets, working from the front end back and gradually building heavier side banks toward the rear. Enough coal rolls to the center of the grate to serve for firing-up. A bundle of wood is placed in the center of the grate near the front end and lighted with waste. The banks are then gradually ignited on top, burning from the top down. As light a blower as possible is used. By this method it is said that the fire can be held for 24 hours or more without smoke violations.

This method of firing-up was also said to have improved road operation. Although after burning for some time the fire looks dirty because of the ash on top, it is said to produce no clinkers and to reduce the total amount of coal used.

To avoid segregation of lumps and fines the practice on the Wabash is to start loading the tender at the front end. The lumps then tend to roll toward the back of the coal space. As the coal is used the lumps then tend to roll forward and a fairly uniform mixture is maintained.

The Baltimore & Ohio and the New York Central have both employed on some of their locomotives revolution counters on the stoker (calibrated in pounds of coal per revolution of the engine) which have been used to educate and stimulate the interest of the firemen in



An electric revolution counter developed by the New York Central for metering coal fired by the stoker

their performance, and as an accurate method of determining fuel consumption during road tests where the fuel preparation is fairly uniform.

Slides were shown of the New York Central instrument which is an electric revolution counter, taking power from the 32-volt locomotive lighting circuit. The counter contacts can be readily and quickly attached to the stoker-engine shaft, and the indicator placed in the cab. Several of these instruments are employed by the fuel department. The coal delivered to the firebox by the stoker screw was accurately determined by weighing coal into the stoker hopper both on road and stationary tests and was found to be about ¼ pound per revolution of the stoker-engine shaft. The amount delivered varies somewhat with the amount of slack, a greater weight of coal being delivered per revolution as the slack increases. When the amount of slack is known or is carefully estimated the weight of coal delivered to the firebox can be obtained with an error not to exceed 5 per cent.

The Baltimore & Ohio has two types. One, applied to the Duplex stoker, consists of a counter of the usual type located in the cab, actuated by a connection to a tripper on the driving rack so that it counts the power strokes of the stoker engine. The calibration of this application indicated an average of 7½ lb. of coal per stroke. Another type, applied to the HT stokers, consists of a flexible shaft drive from the fly wheel of the stoker engine to a speed-recorder instrument located in the cab. The length of the tape used on a run indicates the amount of coal used according to the calibration of the installation which has averaged about 2,000 lb. of coal per inch of tape.

Steam-Turbine and Condensing Locomotives

Progress in installations—Weight ratios of high-speed trains

The four non-condensing steam turbine powered locomotives with direct mechanical transmissions, three in Sweden, and one in England, are, we believe, the only ones in actual service. Germany and France, however, have several designs under consideration.

In this country, the design and construction of a 5,000-h.p. two-unit steam-turbine locomotive with electric transmission, which was ordered in August, 1936, is nearing completion and it has been reported that it will be ready for service in a short time.

During the last few years, several different types of motive power have been built and placed in operation, handling high-speed passenger trains. There is considerable difference in the relative weights of these motive power units and the trains which they are handling. The following tabulation gives general information regarding such motive power units pulling a few of the comparatively high speed trains:

Modern High-Speed Passenger Trains

Railroad	Locomotives: Type	No. Units	Wheel arrangement	Length, ft.	Hp.	Weight, lb.*	Lb. per hp.	Cars: No.	Avg. weight, lb.	Total weight, lb.	Train weight, lb.	Weight of locomotive ÷ weight of train, per cent	Weight of train, lb. ÷ hp. of locomotive
A	Diesel	1	4-4	60	1,800	166,000	138	6	65,000	390,000	596,000	27.8	496
B	Diesel	2	4-4+4-4	120	2,100	370,000	176	9	71,000	639,000	1,009,000	36.7	481
C	Diesel	2	4-4+4-4	133	2,400	429,000	179	10	50,000	900,000	1,329,000	32.3	554
D	Diesel	2	4-4+4-4	132	2,400	438,000	182	11	77,000	847,000	1,285,000	34.2	535
E	Diesel	3**	6-6+6-6+6-6	210	5,400	883,000	164	14	119,000	1,666,000	2,549,000	34.6	472
F	Diesel	3**	6-6+6-6+6-6	210	5,400	878,000	162	14	117,000	1,638,000	2,516,000	34.9	466
G	Diesel	1	4-4	58	1,800	223,000	124	6	73,000	438,000	661,000	33.7	367
H	Diesel	2	4-4+4-4	141	3,600	587,000	160	9	120,000	1,080,000	1,667,000	35.2	463
I	Diesel	2	4-4+4-4	112	3,000	426,000	142	10	83,100	831,000	1,257,000	33.9	419
J	Steam	1	4-6-2	89	3,100	592,000	191	8	152,000	1,216,000	1,808,000	32.7	583
K	Steam	1	4-4-2	90	2,400	528,000	250	9	97,500	877,500	1,405,500	37.6	586
L	Steam	1	4-6-2	80	2,800	609,000	218	7	128,000	896,000	1,505,000	40.5	430
M	Steam	1	4-8-4	107	4,000	822,000	205	12	101,000	1,212,000	2,034,000	40.4	509
N	Steam	1	4-6-4	96	3,500	674,000	187	16	132,000	2,112,000	2,786,000	24.2	796
O	Steam	1	4-6-2	83	3,200	522,000	163	9	130,000	1,170,000	1,692,000	30.9	529
P	Steam	1	4-6-4	102	4,500	772,000	172	16	135,000	2,160,000	2,932,000	26.3	652
Q	Steam	1†	6-4-4-6	122	6,000	1,050,000	175	18	130,000	2,340,000	3,390,000	31.0	565
R	Steam-turbo elec.	2†	4-6-6-4+4-6-6-4	182	5,000	1,060,000	210	16	135,000	2,160,000	3,220,000	32.9	644

* Includes weight of tender for steam locomotives.
** Does not include auxiliary power equipment, carried in first car back of the three power units.
† Not yet in service, train consist assumed.

The following tabulation covers 18 different trains, locomotives and cars for railroads listed as A, B, C, D, etc., of which the first 16 are in regular service.

During the last few years, the design of passenger cars has passed through a cycle from very heavy to extremely light construction and now has settled back to a conservative practical and medium weight construction which provides not only comfort but also safety. Modern passenger cars weigh, in round figures, about two-thirds the weight of older equipment.

The design and construction of motive power apparently has not undergone a change to reduce weight in proportion to what has been done for passenger cars.

Many refinements in design of locomotives have taken place and the efficiency and power per unit of weight have been greatly increased. The general trend, however, has been to increase the number of units per locomotive, the length, weight, number of pairs of wheels and axles, and other parts, all of which increases first cost, and operating and maintenance costs.

These tabulated comparisons of motive power equipment are presented with the hope that the locomotive designers and builders will sharpen their pencils and make greater effort to produce designs which will reduce the number of units, number of wheels and axles, length weight, multiplicity of electrical devices and complications to a minimum. When this is done, it will greatly reduce the first cost, fuel, oil, operating and maintenance costs.

The report was signed by L. P. Michael, Chairman, C. & N. W.

Oil-Firing Practice

Committee seeks to formulate recommended practice for cracked, heavy and blended fuels

For several years this committee has discussed various phases of the effect of cracked, heavy and blended fuels on locomotive firing practice. It was thought that this year's report might put in more definite form recommended practices. However, apparently due to the wide range in quality and character of the heavy fuel oils, it seems too early to accomplish this.

If the oil-burning men, whether or not you are on this committee, will submit definite recommended practices, it may be possible to place a more detailed report in shape for next year. There are many problems involved, such as:

1—Are cracked and heavy fuels now used by all oil-burning roads?

2—Is it possible to obtain the same quality of fuel for all divisions of a railroad so that the same instructions will apply everywhere?

3—Does the quality—chemical or physical characteristics—vary frequently, making it necessary continually to change instructions?

4—Is the best firing fuel temperature fairly well standardized, or does it vary due to quality of fuel, the season, etc.

The report is signed by R. S. Twogood, Sou. Pac., Chairman; L. E. Dix, T. & P.; G. L. Schneider, St. L.-S.F.; S. R. Tilbury, A.T.&S.F., and K. W. Muhl, West. Pac.

Discussion

A great part of the discussion was devoted to methods of heating the oil in tank cars preparatory to unloading and in the locomotive fuel tank, and the problem of water in the oil arising from the use of the open-jet method of heating.

The Santa Fe has equipped its oil tank cars with coil heaters. Prior to this the water in the oil ran from 5 to 15 per cent, with as much as 20 per cent in the tender tank. It was said that locomotives will steam with as much as 30 per cent water if an open jet is employed in the fuel tank to keep the oil and water sufficiently agitated. Nevertheless, the discussion indicated that where it is present, it is a potential source of delay.

Two other suggestions were made for the elimination of water from the oil preparatory to unloading. One was to place the oil cars in a heated building several days prior to unloading and thus avoid the necessity of applying heat directly in the car. The other was to draw the oil from a point slightly above the bottom of the storage tank and drain off the water as it settled to the bottom.

On the St. Louis-San Francisco, as oil has become heavier with the progressive development of cracking in the refinery, changes have been made in the oil pan and burner arrangement. More air has been admitted around the burner and the oil is kept at 180 deg. On the Santa Fe the draft pans have been lengthened from 50 to 70 in. and air admitted through the fire door under damper control. This is said to have reduced carbon deposits in the fire pan. The Santa Fe fireboxes are bricked on the back wall up to the door opening. No brick is applied on the other walls of the firebox.

The discussion indicated that exhaust-nozzle tips on oil-burning locomotives run from ¼ to ½ in. larger than those on similar coal-burning locomotives.

Supervisor of Fuel Conservation and Improved Railroad Operation

A free lance who tactfully coordinates activities and conditions in many departments

Because there is hardly a single detail of railroad operation that does not have some effect upon the utilization of the locomotive fuel and because practically every railroad employee in some phase or other of his activities contacts some of the details that are involved in the general problem of fuel economy and influences to some extent the degree of economy that is obtained in the utilization of the locomotive fuel, the supervisor of fuel conservation is properly a free lance officer and his authority and responsibility should extend into practically every branch of railroad operation and into contact with every group of railroad employees.

On any railroad where fuel conservation work is given the important status warranted by an intelligent appraisal of its value, it will be found that the supervisor of fuel conservation, by whatever local title he may be known, is tacitly endowed with such responsibility and expected to assume—tactfully of course—such authority, whether or not his instructions specifically so state.

It is generally recognized that over the period of the past 25 or 30 years the remarkable improvement in the economy with which locomotive fuel is utilized has been accompanied by and greatly influenced by the remarkable parallel improvement in practically every other phase of railroad operation. No one phase can for long remain out of step with the improvements effected in other phases—they are all more or less definitely geared together, motive power, car equipment, roadway, track, signals, maintenance of equipment, maintenance of way and methods of conducting transportation. Improvement in any one department helps all the others or forces them to improve. There will be little disagreement with the viewpoint that the best possible fuel performance on any railroad will go along with the best possible job of railroad operation in all its phases.

The supervisor should give special attention on his districts to the operating conditions of the locomotives in service on his territory to eliminate any waste of fuel and engine failures. In order to know these conditions, check must be made of condition of power at engine-house and performance on the road. It is correction of defective conditions before fuel losses and engine failures occur that will improve transportation service and reduce the transportation expense in many directions.

The supervisor of fuel conservation can exercise a

most potent influence for improvement in railroad operation by consistent missionary work with the engine terminal employees, the hostlers, the engine watchmen, the fire cleaners, the fire builders, the flue cleaners, the boilermakers, the machinists, their helpers and the supervising officers who direct them. The individual employee in each of the various classifications can affect the final result in proportion to the care and skill with which he does the job to which he is assigned, and the thoroughness with which he carries out the standard practices which have been established to direct his activities.

One of the most important features of engine-terminal operation is the thorough cleaning of flues in the locomotives dispatched. It has been determined from tests conducted for the purpose that the plugging of five superheater flues will increase the coal consumption five per cent, and the plugging of 25 small flues will increase the coal consumption to an equal extent for the same steam production by the locomotive. Dispatching locomotives with all flues clean will therefore save 10 per cent of coal as compared with locomotives permitted to run with this small number of flues plugged.

It is clearly within the province of his responsibility and authority for the supervisor of fuel conservation to emphasize repeatedly to the supervising officers of the engine terminals that, in the interest of fuel economy and good railroad operation, locomotives should not be dispatched until it is a reasonable certainty

(a) that the injectors will operate through the proper range to allow continuous boiler feeding and not make it necessary alternately to over-feed, then shut off.

(b) that the stoker is in proper adjustment to feed coal steadily and allow good distribution of the coal without the use of excessive jet pressure or excessive steam consumption by the stoker engine.

(c) that the grates are clean of clinker and will latch level and not rattle enough to loosen the fire or require the carrying of an excessively heavy fire.

(d) that the brick arch is full length specified for the firebox and tight and clean.

(e) that the superheater units are tight at the header.

(f) that the smoke box is tight against air leakage and the draft appliances in correct adjustment.

(g) that the power reverse will stay put as set and not "creep."

(h) that the valve gear is in good adjustment for economical steam distribution.

(i) that valve packing and piston packing is tight against "blows."

(j) that the air-pump is operating efficiently.

(k) that the lubrication appliances are functioning properly.

(l) that the tender is supplied with the most suitable grade of the coal available on the tipple for the service to be performed by the locomotive.

Another important field for the supervisor of fuel conservation's special attention consists in close and constant check on the utilization of locomotives in service on his territory, with the object of keeping in service only the minimum number necessary to handle the business, by storing every engine not definitely needed, thereby reducing as much as practicable the supplementary locomotive mileage, resulting from excessive running of double-headers and light engines, all of which not only consumes extra fuel, but also increases maintenance, engine-terminal and other transportation expenses. Where longer locomotive runs can be arranged or there are opportunities to turn engines back without terminal attention, it would bring about a more economical operating cost. Upon every possible occasion suggestions should be made to the superintendents for increasing engine load and reducing excessive running speed in every case where schedules will permit. Unnecessarily high speed results in excessive maintenance costs as well as high fuel consumption, particularly with locomotives not designed for the high speed running.

Among the many details that profitably engage the attention of the supervisor of fuel conservation are the constant following up of road delays due to hot boxes, defective draft gear, rough handling, faulty air-brake equipment and air-brake handling, slow orders, proper handling of blow-off cocks to keep water concentration where engine will lubricate most efficiently, delays in taking coal and water. In order to avoid delay in taking water many roads today with larger power have tanks of 17,000 to 22,000 gallons, which have reduced expense of upkeep to equipment due to less frequent stopping with heavy tonnage trains.

The supervisor of fuel conservation can make an important contribution to the improvement of railroad operation by making regular periodical close checks of delays to locomotives in terminals, both in enginehouse territory and in transportation yards, which affect the utilization of the locomotives, the number required in service and expenses of operation in addition to the fuel expense. In order to reduce these delays the enginehouse forces must know that proper supplies, such as fuel, water, lubrication and proper tools have been provided for the engine crew so they can leave enginehouse on the time called for.

Because of the general nature of his interest in the operation of his railroad the supervisor of fuel conservation is in position frequently to make suggestions to the superintendents of methods by which the various departments may coordinate activities to improve the general operation. In train yards there should be no delay waiting for trains. Yardmasters should have close line-up on train arrivals and amount of switching required so that closer figure can be given as to when yards will require power, thereby eliminating terminal delay.

A division superintendent is presented with no better opportunity to influence a substantial saving in cost of operation than through giving his personal supervision to the feature of cooperation between his dispatchers and yardmasters on the one hand, and his roundhouse foremen on the other hand in the matter of calling time and dispatching time for freight locomotives. The average freight locomotive uses 400 to 500 lb. of coal per hour standing under steam in terminal. Careful calling of power and adequate organization for preparing locomotives for the crews when and as needed are necessary in order to avoid very heavy waste of coal between the time of firing up and the time of leaving the engine terminal. An average of ten engines per day fired up an hour earlier than necessary will waste enough coal to pay the additional firebuilder whose services might be necessary during the busy dispatching period of the day, to make it practicable to avoid this waste of coal, and in such a case the railroad money would be used to employ a railroad man instead of going to a coal miner.

By reason of the nature of his activities and contacts with the details of the railroad operation the supervisor of fuel conservation is in particularly good position to influence reduction in delays due to poor dispatching, such as running freight trains on the time when superior trains must be cleared, also excessive delay in meeting trains which bring about not only terminal delay, but delay enroute, and where excessive delays occur and the delays must be made up, it results in increased fuel consumption per 1,000 gross ton-miles.

The supervisor of fuel conservation should also ob-

tain and pass on suggestions of engine crews and train crews for improvement in operating methods. When supervisors contact engine and train crews about the terminal or out on the line many good suggestions of improvements have been brought out. When good constructive suggestions have been brought up, members of the crew should be given credit for their interest, which will bring about greater interest upon their part to have poor practices corrected.

Another very fruitful field for the activities of the supervisor of fuel conservation on coal-burning railroads, and one which is not generally given the attention it deserves, falls under the general heading of systematic supervision over the preparation, segregation, and utilization of locomotive coal. The experience of many railroads has demonstrated that not only have they saved considerable fuel, but they have greatly aided in the general train and locomotive performance by following such a policy.

The report was signed by G. E. Anderson, Great Northern; P. E. Buettell, C. M. St. P. & P., and A. A. Raymond, N. Y. C.

Discussion

The results of New York Central standing tests on various preparations of egg and slack coal, in which the percentage of slack was varied, showed that the consumption increased with the increase in the percentage of slack. The results of these tests form a basis for determining the most economical mixture from the standpoint of over-all cost. In answer to questions concerning the standing tests, it was developed that a water spray is introduced into the cylinders when these tests are under way in order to de-superheat the steam and produce a condition at the exhaust similar to that made in regular service. This increases the volume of steam and, through a large pipe connected to both exhaust passages, an amount of steam is bled off equal to the amount of water introduced.

As a result of the tests the capacity of locomotives which seemed to have been exceeded under the speed-up of schedules during the past few years has been increased until the performance of these locomotives is still equal to the demand. The exhaust-nozzle diameter was increased from 6¾ in. to 7 in.

Reference was made to the value of the Loco Valve Pilot as an aid to the engineman in getting full performance from the locomotive. Inspections of the tape records from this instrument are said to show a surprising degree of uniformity in performance. With this instrument, it was pointed out, the engineman is not dependent upon the sound of the exhaust as a guide to his performance and does not have to learn the sound of the locomotive all over again following a change in the front end.

A considerable part of the discussion following the presentation of this report dealt with the preparation of coal at the mine. The need of attention to keep impurities in mechanically loaded coal down to a satisfactory point was stressed. An objective of 750 lb. of foreign matter per car was suggested in this connection. Coal loaded with loading machines in the mine frequently runs as high as 1,700 to 1,800 lb. of foreign matter per car. The value of washers in reducing ash from as high as 15 to 20 per cent down to 10 per cent was also mentioned. The disadvantage of the washed coal, however, lies in its higher moisture content which prevents it from running well in the chutes. To overcome this the installation of a coal laundry at an Illinois mine was cited where the coal is dried following washing so that the moisture of the coal leaving the plant is below that of the coal in the seam itself.

Utilization of Locomotives

Main line coaling stations a factor in increasing length of runs

The service from our locomotives, under adverse business conditions, on the thirteen largest railroad systems in the country for June of this year is shown in the table.

Locomotive-Miles per Active Locomotive Day

Road	Miles per active locomotive per day		
	Passenger	Freight	Switch
Atchison, Topeka & Santa Fe	271.3	129.4	66.4
Atlantic Coast Line	140.1	75.4	41.7
Baltimore & Ohio	214.2	102.8	65.2
Chicago & North Western	158.8	97.7	55.0
Chicago, Burlington & Quincy	187.0	97.1	56.5
Chicago, Milwaukee, St. Paul & Pacific	182.1	97.0	68.3
Chicago, Rock Island & Pacific (includ. C. R. I. & G.)	189.4	110.0	63.2
Illinois Central (includ. Y. & M. V.)	127.8	73.8	50.1
New York Central	224.7	123.3	74.9
Pennsylvania R.R.	200.5	108.1	76.9
Southern	156.9	78.2	41.7
Southern Pacific Co.	213.4	106.8	69.5
Union Pacific R.R.	268.5	101.7	69.6
Districts:			
Eastern	172.9	102.4	68.4
Pocahontas Region	153.2	86.1	65.5
Southern Region	148.0	85.7	49.3
Western	194.7	100.9	60.9
United States	176.7	97.9	62.5

In passenger service the highest mileage per active locomotive day was obtained on the Santa Fe—271 miles. Perhaps a fair speed in passenger service for the country as a whole can be accepted as 35 miles per hour, so that 271 miles represents 7¾ hours service per day. In freight service the highest again is the Santa Fe—129 miles per active locomotive day. Our last full year's statistical reports indicate a freight-train speed of approximately 16 miles per hour so that, dividing the 129 miles by 16, we find that the freight engines are working approximately eight hours a day. In switch service the highest mileage is obtained by the Pennsylvania System—77 miles per active locomotive day—and this is based on six miles per hour, so that it represents nearly 13 hours' service.

Road locomotives working approximately eight hours a day and yard engines thirteen hours a day is being accomplished by only a few systems. It is, therefore, not necessary to discuss how we could get an average of twelve hours a day from our road engines and sixteen from our switch, but rather to discuss whether it is possible to obtain eight hours a day from the road engines and thirteen from the switch. Thus, theoretical figures are not being discussed, but figures obtained in every-day practical operations on large systems.

What Interferes with Improvement?

What interferes or prevents road engines, in general, from working eight hours a day and what interferes with

switch engines, in general, working thirteen hours a day? Perhaps the reasons come under some one of the following headings:

1—End of the road (or train does not go any further).
2—Because of necessary switching the train will be held in the yard for three or more hours.
3—Two trains are combined so there is a surplus of one locomotive.
4—The train goes to a division using a different class of power.
5—The ash pan is full.
6—All the available water has been used out of the tender cistern.
7—The coal has all been used.

These are days of fast schedules. Trains cannot be held at stations a long time while locomotives go to the coal dock for another tender load of coal, so if there is no coaling facility on the main line it means that an extra locomotive must be provided, fully coaled, so that the train can move forward promptly.

Changing Engines Makes Coal More Expensive

Changing locomotives, of course, loses the time of the locomotive taken off. Considering a typical 24-hour day, the average loss of time is perhaps five hours before this engine is coaled and returned. Suppose that a passenger train averaging about 60 miles per hour burns, perhaps, three tons an hour so that after nine hours' work it is necessary to take the engine off to get 27 tons on the tank and that, in obtaining the 27 tons, the engine is out of service approximately five hours; that is, for every nine hours the engine works it is idle five hours, or it is working 64 per cent of the time. This, carried through, would indicate that it takes 1⅓ locomotives to do the work of one engine and that this is because it needed a tank of coal.

Let us suppose that coal is worth $2 at the mine and it costs about $1 more to get it from the mine onto the locomotive, or an average cost of $3 a ton for the 27 tons, or $81. To this $81, however, must be added the cost of fuel used in going to and from the enginehouse, cleaning or dumping the fire, perhaps the extra cost of handling a locomotive through a large enginehouse organization if no repairs are needed, and the value of a locomotive for five hours at at least $1 an hour, so that we have:

$81 for coal
3 for coal burned to and from the enginehouse, cleaning and dumping the fire
5 for extra enginehouse cost
5 for the value of the engine while out of service

$94 total

Divided by the 27 tons, this gives approximately $3.50 a ton; that is, 16 per cent increase in the cost of coal, because the coal wasn't handy.

In freight service the picture is the same. A locomotive, making perhaps 40 miles per hour and using perhaps four tons of coal each hour on a division run of 150 miles, would then use 15 tons—some left but not enough to make the next terminal. On a symbol freight, with the coal dock at the enginehouse out of the way of the yard, for prompt handling of the train it is advisable to supply another locomotive.

In this case $45 worth of coal and similar expenses for coal to and from the enginehouse, regular enginehouse expense and five hours out of service for the locomotive makes a total of $58 for 15 tons, or a little over $3.85 a ton—another increase of 28 per cent in the cost of fuel because the coal wasn't handy.

Switching locomotives are working 16 to 24 hours in many yards, but these engines burn very few tons of coal in a 24-hour period. Hence, if coal were available and the fire maintained in reasonably good condition, it is only necessary to clean the fire after extended intervals where there is a possibility of working the locomotives for 24 hours. Of course, there are many yards where there are only a few 24-hour jobs available. Suppose a locomotive needs six tons of coal and, again, that the facilities are not handy. [The ash pit and coal dock should be part of the general yardmaster's and chief car inspector's office.]

The six tons of coal cost, perhaps, $18, made up of $3 for the ton of coal used while the engine is out of service, $2 for enginehouse expense and $7 for the time the engine is idle before she can be returned, or $30, an average of $5 a ton. This is an increase of 66 per cent in the price of coal because of the fact that the facilities were not handy.

Convenient Coal Chutes Keep Locomotives at Work

Many roads have ash, coal and water facilities for freight and switch power handy so that, for instance, if a symbol freight train comes into a yard and a few of the cars require icing, etc., the engine can be run to a handy pit where the fire will be cleaned, the engine will be coaled, take a tank of water without moving and necessary inspection can be made so that by the time the train is iced and the cars are being shoved down into the yard the engine can couple on and start pumping the air. This, perhaps, can be a spur off the ladder with an inexpensive coal-handling plant such as we see in all of our local coal yards. One can be obtained that will deliver two tons a minute at almost infinitesimal expense when the cost of it is compared to the cost of using another locomotive. In the case of a freight locomotive there is a bonus of $8 to $13 for every locomotive handled in this way.

In the case of a switching locomotive there was one yard where it was possible to put one of these small coal facilities on an unused spur track. The yard crew during their lunch period set the engine on the track over the ash pit and when they finished lunch she had coal, water, fire cleaned, and was ready to go back to work, with a bonus of perhaps $10 for every engine handled in that way. Of course, if any of these engines are found to need roundhouse repairs, they are immediately sent to the house.

The proceedings of all mechanical department meetings would seem to establish the fact that substantial economy results from long locomotive runs, because fewer engines are needed, fewer housing facilities required, and because the fuel used in enginehouse territory is saved. The reliability of modern locomotives has been proved on many through runs, and high individual locomotive mileages are a matter of record. The question, then, would seem to be why don't a majority of the locomotives run through and why is the mileage per locomotive day, as reported by the Bureau of Railway Economics, so low?

The report was signed by A. A. Raymond, chairman of the Committee on Utilization of Locomotives.

Discussion

Attention was directed at the limitations on the average miles per active locomotive day as a basis of rating the utilization of locomotives on various railroads. Unless the relation between branch-line miles and branch-line train-miles to main-line miles and main-line train-miles are known, the comparisons are sure to be deceptive. Consideration must also be given to the fact that increasing train speeds are reducing locomotive-hours on the road and increasing the proportion of total hours spent in the engine terminal.

The Atchison, Topeka & Santa Fe has been particularly successful in developing long passenger locomotive runs.

For these runs oil is used for fuel over the entire line. The runs are between Chicago and La Junta, Colo., a distance of 992 miles, and between La Junta and Los Angeles, Calif., a distance of 1,235 miles. The tenders carry 20,000 gallons of water and 7,000 gallons of fuel oil. Fuel is taken twice between terminals on each of the runs. The use of Foam-Meters on the passenger locomotives was mentioned particularly as a factor in improving conditions on these runs. Where formerly the locomotive required a water change at one end of the run and a washout at the other, it has now become possible to run the locomotive a full 30 days between washouts. The Foam-Meters are now being installed on freight locomotives.

It was reported that the Santa Fe is now getting 18,000 miles per month on long-run assignments, but has set 20,000 miles per month as the goal.

In connection with the high average miles per active locomotive day it was pointed out that the Santa Fe has fewer branch-line miles than the average, so that the long main-line runs have a relatively larger influence on the statistical average than is the case on many other large systems.

One of the factors which tend to reduce the average miles per month on locomotive assignments is too large a supply of active locomotives. Where some locomotives run from 14,000 to 16,000 miles, it was pointed out that most of the locomotives would not exceed 6,000 miles per month. This condition can only be overcome by a definite assignment of locomotives to regular runs and insistence that they be kept on those runs.

The problem arising from a supply of a variety of coals on long locomotive runs in coal-burning territory came in for lively discussion. The practice of keeping a locomotive on a run where it comes into the terminal with a clinkering coal and will continue with a better grade of fuel was questioned from the standpoint of fuel economy. One speaker estimated that from one to two tons less of the good coal would be burned if a locomotive with a fresh fire were placed on the run instead of the incoming locomotive. On the other hand, the experience of both the Alton and the Frisco was cited on long runs in which the locomotives burned four grades and qualities of fuel, some having ash of relatively low fusing point, without the necessity of cleaning the fire. Where such practice prevails attention was called to the need of drafting the locomotive to suit the fuel requiring the sharpest draft. To prevent clinkering of the fire when burning coal having ash with a low fusing point, it is the practice on the Alton to open the blower before the throttle is closed. This prevents a back draft of hot gases from the fuel bed through the ash, which is one of the causes of clinkering. While it was not maintained that this practice might not burn more coal on the road than would be the case where but one kind were burned on a single locomotive, the locomotives are said to burn less total fuel in continuous service than would be the case if they were held at intermediate terminals.

Archaic Details in Locomotive Design

Pointed questions concerning conventional features which affect fuel economy

By F. P. Roesch

Vice-president, Standard Stoker Company

The past few years has witnessed a decided change in operating conditions. Speed and more speed is now the watchword, and this means not only speed between terminals but reduced delays at such points. We can no longer tolerate the delays incidental to cutting the engine off, backing it down to the cinder pit to clean the fire, etc., where crews are changed. On the contrary, the fireman is expected to keep the fire in such condition that, when arriving at the change point no further attention is required. This calls for a 100 per cent job of firing, without fire cleaning, regardless of the length of engine run. It can be done when conditions are right.

Clinkers and Banks

In many quarters the impression still prevails that the formation of clinkers in a locomotive firebox is due altogether to the character of the coal or the manner in which it is fired, or both. That theory still holds good where locomotives are manually fired, but where mechanically fired under conditions suitable to mechanical firing, can be thrown into the discard.

The above statement may be challenged on the grounds that any coal producing an ash of a low temperature fusing point will also produce clinkers. We do not dispute that statement, but do maintain that more clinkers are caused through improper fire conditions, viz., uneven thickness, etc., than are directly due to fuel characteristics. Often these conditions are due to correctable factors over which the fireman has no control. It is our job to correct such conditions as far as we can. As we cannot change the characteristics of the fuel, and as the fireman is doing the best he can under the circumstances, we must attack the problem from the mechanical angle and recommend such construction changes as will tend to reduce, or if possible eliminate these bad fire conditions.

This points directly to a correctable construction that is one of the primary causes of clinkered fires where the coal is inclined to clinker, or to conditions equally responsible for fuel waste with what is termed "good" or non-clinkering coal. The results are practically the same from a combustion standpoint, regardless of whether the inflow of air through the fire is restricted by clinkers or a heavy bank, as we only get surface combustion at such points and the remainder of the grate area must carry the full load. This results in a higher than the economical rate per square foot of grate over the remaining or effective area, with the usual attendant fuel loss.

Sloping Grates

When trailer trucks with inside journals were first introduced, it was necessary to elevate the rear end of the mud or foundation ring in order to provide clearance for springs and spring rigging. This construction resulted in a grate having a pronounced downward slope from the rear to the throat sheet. While this construction offered no serious impediment to good firing when locomotives were operated at medium speeds, it does materially affect fire conditions today, as the excessive oscillation of the locomotive at speed, results in the fire bed creeping forward—creating a heavy fire at the forward end of the firebox and a thin fire at the rear. This condition prevents the admission of sufficient air in front to support combustion, and admits too much at the rear,

thereby in effect restricting the effective grate area proportionate to the amount covered by the heavy fire. The inside-journal trailer truck is largely a thing of the past, but the sloping grate is still with us. Why?

While on the subject of sloping grates, we may as well consider what are termed "hog trough" or "basket grates," some of which are still in service. These grates slope from the sides to the center, forming what might be termed a longitudinal trough or basket, with sides higher than the center.

When we were first taught the art of firing we were instructed to fire along the sides and also keep the corners, particularly the back corners, full, i.e., keep the fire heavier along the sides and in the back corners; this to avoid the inrush of cold air at these points. Obviously, with the hog trough type of grate this is quite a task and usually results in a gradual increase in fire bed thickness through the center, creating a condition not conducive to good combustion. Therefore, we believe we can consistently recommended the leveling up of such grates where they occur, especially where locomotives are mechanically fired. The improved overall combustion, with the attendant reduction in fuel consumption, will more than offset the expense of the change.

Sloping Backheads

The majority of locomotive mechanical stokers fire through the door opening or through holes piercing the boilerhead at about the level of the firedoor opening. In order to obtain proper distribution, it is necessary to extend the distributing plate from six to eight inches beyond the door sheet. Where the slope of the back boilerhead is excessive, it is necessary to propel enough coal backward to cover an area equal to the distance from a vertical line from the end of the distributing plate to the door sheet at the grate level, multiplied by the width of the firebox. This area may be from four to six square feet. As projecting coal backward mechanically presents certain difficulties, the area mentioned above is frequently covered by "dead grates," thus reducing the effective grate area by that amount. Why an excessive backhead slope?

The demand on a locomotive boiler is not constant, but varies from full load to no load. Therefore, we cannot set up a definite ratio as between steam requirements and grate area. The best we can do is to arrive at some compromise that will result in a fairly low rate per hour at light or no load, but not an excessively high rate at maximum demands, as either results in fuel waste. The result of such compromise may be a combustion rate varying from say 30 lb. at low demands to 150 lb. or more per sq. ft. of grate per hour at maximum requirements.

Haslam and Russell, in "Fuels and Their Combustion," 1926, state that where the fire is loose and of a depth so that air can pass through it freely, all the oxygen in the air admitted has combined with the carbon in the fuel in the ratio of one atom of carbon and two of oxygen, producing CO_2, and that this combination is completed at from 4 to 4½ in. above the bottom of the fuel bed, except with lignite, where it is completed at from 2 to 2½ in.; the measurement in each instance beginning at the top of the ash bed. Quoting directly: "That portion of the fuel bed above the oxidation zone is a reducing zone where the CO_2 formed in the oxidation zone is partially reduced by the coke to CO. The thicker the fuel bed the more CO is formed. Since the object sought in the combustion of coal on a grate is to burn it with oxygen from the air, any reduction from CO_2 to CO is a step backwards. Consequently, the fuel bed should be no thicker than is necessary to prevent blow holes. Blow holes are caused by the unevenness in the distribution of coal on the grate or anything, such as clinkers, that produces uneven resistance to the passage of primary air up through the fuel bed."

As the heat value of CO_2 measured in B.t.u. is 14,500, while that of CO is but 4,500, it requires no slide rule to approximate the fuel or heat loss due to imperfect fire conditions.

Dead Grates

Consider now the effect of dead grates, with which we can also include dump grates. Haslam and Russell's experiments indicate that the fire bed must be kept relatively loose in order to obtain good combustion. Obviously this cannot be done on a dead or dump grate. We therefore have on the area taken up by such grates a condition practically the same as the one previously mentioned. And yet there are in service today locomotives where from 20 to 35 per cent of the total grate area is taken up by dead and dump grates. The reason given for this condition is that the coal fired is inclined to clinker, therefore the need for many and large dump grates to facilitate fire cleaning. The fact is entirely overlooked that dead and dump grates are conducive to clinker formation, from which we could logically conclude, less dump grates, less clinkers, and with less clinkers, less dump grates and less time for fire cleaning. Cannot this association take the position that the number and size of dead and dump grates can and should be reduced or entirely eliminated under present conditions?

Air Opening Through Grates

Of course, where locomotives are mechanically fired, all oversize lumps are mechanically reduced to proper firing size before introduced into the firebox. In this reduction, naturally more fines are created than originally contained in the coal. To guard against loss, both stack and ashpan, it became necessary to adapt the grates and draft to the size of the coal as fired, and where this was done logically, it was immediately observed that the results justified the cost.

The introduction of mechanical firing has done more to promote fuel economy than any one other appliance except the superheater, as it compelled the use of a logical grate. It is unnecessary to dwell on the grate of the past, viz., the finger type, except to say that this type of grate had perhaps a greater influence on fuel loss—at both ashpan and stack—than any other part of the locomotive, an influence that was not realized until the introduction of mechanical firing. To that design of grate can be charged directly the cinder loss, always until recently attributed to the size of the coal as fired. As all stokers must reduce oversize lumps of coal to sizes suitable for mechanical or steam jet distribution, and as in this reduction some small sizes are necessarily produced, the stoker manufacturers in self-defense had to prevail on the users of mechanical stokers to resort to a grate suitable to the coal as fired, and when this was done another old theory, viz., that stack loss is proportionate to the size of the coal fired, was exploded and can also be thrown into the discard.

Perhaps the credit for fuel reduction should be evenly divided between the stoker and the modern restricted grate. At any rate, the first compelled the adoption of the second, and the second saved the reputation of the first. However, regardless of which should have the credit, we can consistently recommend the adoption of the restricted grate and consign the finger type to the limbo of avoidable factors in locomotive design affecting fuel consumption.

While engaged in exploding old theories, we must not overlook the setting of the brick arch. The lower end of this arch was usually set about 5½ in. from the throat sheet, on the theory that such setting prevented the stoppage of the lower tubes with cinders. But when tests proved that the draft immediately under such opening was more than twice as high as over any other part of the grate area, and as a result of this high draft the finer particles of coal suspended in the draft current were whipped through this opening, through the lower tubes and so on out of the stack, that theory also went haywire and the arch was sealed against the sheet, so that now any fine particles of coal suspended in the draft, strike the arch, fall back on the fire bed and are consumed, instead of being discharged from the stack and lost. So the setting of the brick arch can also be listed among avoidable factors.

Heating Surface

Locomotive designers are beginning to give more thought toward decreasing the length of the boiler tubes and increasing the length of the combustion chamber—a step in the right direction. Dr. W. M. F. Goss upset the old theory of the relative value of firebox and tube heating surface at the Coatesville tests, but the lesson to be drawn from that test was not fully appreciated in all quarters. However, time marches on and leaves old theories behind. Aside from the difference in value of heating surface, it has been found that a better diffusion of draft over the grate area can be obtained where a combustion chamber is employed than without one. Not only that, but a more complete combustion of the gases is possible, and further, a possible reduction in cylinder back pressure due to less draft restriction and resultant lower front end vacuums required. So let us include long tubes and short or no combustion chambers among our avoidable factors.

Draft and Back Pressure

Many attempts have been made to reduce cylinder back-pressure, but so far without entirely satisfactory results, due primarily to failure to fully recognize the fact that the boiler output is dependent on the coal rate, and that this in turn is governed by the draft, and that with present nozzles of a fixed dimension we automatically obtain a firebox draft proportionate to the steam demand.

True, in starting or at low speed and long cut-off, the draft is excessive and indicates a possible advantage in a variable nozzle, but this when weighed against the disadvantage and the fact that in many cases the nozzle is not the dominating factor in the production of back pressure, prompts the consideration of other factors involved, such as restricted exhaust passages, etc.

Present cylinder design includes the valve chambers, cylinders and saddle in one integral casting. If now, instead of leading the exhausts from each cylinder through tortuous and sometimes restricted passages to the exhaust stand, all such passages were eliminated and the exhausts were conducted direct to the saddle chamber, we should gain a possible reduction in back pressure through reduced friction in exhaust passages, but also a reduced exhaust pressure and draft at low speeds and long cut-off through the expansion of the steam into an increased volume before its final discharge.

Such an arrangement holds further attractive possibilities, in that such a chamber would serve as a very effective by-pass, particularly if the exhaust from auxiliaries were also piped into this chamber, in which event the oil-saturated steam from these auxiliaries would serve as an effective lubricant for the valves and pistons while drifting, and so eliminate the use of a drifting valve or drifting throttle taking live steam directly from the boiler. The amount of steam used for drifting purposes has not been measured recently, but in tests conducted some years ago it was found necessary to employ a two-inch pipe from the boiler to the saddle in order to sufficiently dilute the gases drawn from the front end through the exhaust nozzle to prevent the carbonization of the oil and its deposit in the exhaust passages and on the pistons and valves.

Conclusions and Forecast

While the locomotive of today has incorporated one or more of the features mentioned, the high speed locomotive of tomorrow will have all of them, viz., a softer exhaust, a level restricted grate, a sealed extended arch, increased combustion volume compared to grate area. It will burn semi-pulverized coal, fired mechanically without fear of cinder loss and with much greater efficiency than under present methods, which means greater heat transfer and higher superheat. In other words, engineers will devote more study toward increasing combustion efficiency and in so doing, increase overall efficiency, as the one goes hand in hand with the other.

The locomotive will retain its present general outward appearance, and while the streamline effect will no doubt be retained for its advertising value, the boiler and particularly the firebox end and related parts, will witness the most detailed changes, as improvement in the generation of steam is a fertile field and one wherein we find the greatest promise at the least expense.

Discussion

Referring to Mr. Roesch's remarks concerning the sloping back head, it was suggested that it might even be desirable to pull the lower part of the back head inward to bring the back corners in front of the point from which the coal is distributed. The question was raised later, however, whether such a change might not lead to staybolt trouble much the same as that now experienced in the throat sheet.

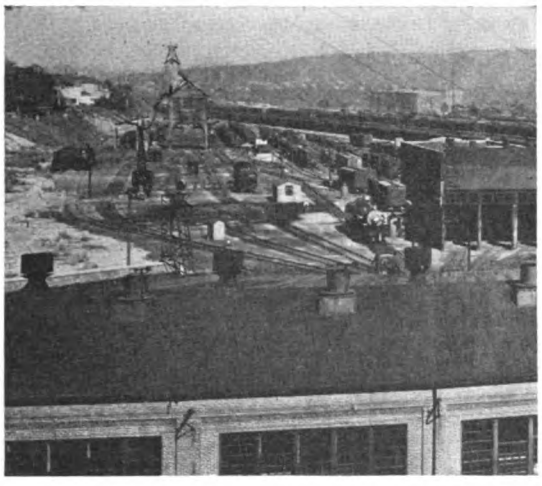
The employment of large radii at the back corners of the firebox was cited as one means of overcoming some of the difficulty in the distribution of coal to the back corners of the firebox. This also was said to have improved the circulation on the boilers.

An attempt to replace sloping grates with level grates in existing motive power was cited in which the loss of heating surface and the reduced combustion space between the front end of the arch and the fire proved to be serious drawbacks. The use of plates to reduce the air opening at the rear of the grate has helped somewhat, but was said to have, in effect, reduced the grate area and the firebox capacity.

The front end came in for a considerable amount of comment during the discussion. Instances were cited where the refinement of the front end had increased the capacity of locomotives. The desirability of some form of variable exhaust was also referred to.

Several persons also referred to the need for a closer knowledge of locomotive capacity and just where the reverse lever should be placed under varying conditions to get the best performance.

Reference was made to the use of the Wagner drifting valve on the Santa Fe which serves to effect some reduction in the amount of braking required on long mountain grades.



International Railway General Foremen's Association officers suggest change in name of that organization

Problems of

Locomotive Maintenance

At the same time that the other mechanical associations were holding meetings in Chicago on Tuesday, September 27, the officers and executive committee of the International Railway General Foremen's Association discussed the future of that organization and made plans for a three-day meeting in 1939.

In reviewing the past work of the organization, as well as its present status, it was believed wise, in order not to interfere with other mechanical associations, to limit its activities to problems concerned with locomotive maintenance. The Mechanical Division, A. A. R., deals with standards and recommended practices of locomotive design and construction. The Railway Fuel and Traveling Engineers' Association concerns itself with problems relating to locomotive operation and fuel economy. The General Foremen's Association heretofore has always included car department subjects in its program, but it was felt that these should be left entirely to the Car Department Officers' Association.

In keeping with this new conception of its field, it was decided to recommend to the convention next year that the name of the International Railway General Foremen's Association be changed to the Locomotive Maintenance Officers' Association and that its membership include all officers and supervisors interested in locomotive maintenance. While this will limit the range of subjects to be considered, it will greatly intensify the work of the association and should bring into its membership important mechanical department officers, who up to this time have had no organization in which they could find a place to express themselves on the great variety of questions relating to locomotive maintenance in both the back shop and the enginehouse, including problems of administration as well as of practice.

Here, for instance, is a place for general mechanical staff officers interested in such problems—as an example, system supervisors of shop tools and machinery, apprentice supervisors, mechanical engineers and such of their assistants as may be specially interested in locomotive maintenance questions, representatives of the engineer of tests, etc. Obviously it will include general master mechanics and master mechanics who have a considerable interest in locomotive maintenance problems, shop engineers, shop superintendents, enginehouse foremen, chief locomotive inspectors, apprentice instructors and all shop foremen having a relation to locomotive maintenance, with the exception of those in the boiler shop, who have an association of their own.



F. B. Downey, President

It will be recalled that at a meeting of the Committee on Co-ordination of the Mechanical Associations, held in Chicago on July 25, the announcement was made that the American Railway Tool Foremen's Association would affiliate with the International Railway General Foremen's Association and that efforts would be made to revive the International Railway Master Blacksmiths' Association and to affiliate it with the General Foremen's Association. Pending final action in these respects, the

program for next year will include topics of special interest to these groups. There is always the possibility in the future that one or more separate sessions of the convention may be arranged for them if they indicate a sufficient interest. Obviously many problems of primary interest to these groups will also commend themselves to the other members and can profitably be given consideration by most of them.

Arrangements were also made for a special effort to build up the membership of the association during the year.

Next Year's Program

In planning for the three-day convention next year the following committee subjects were selected and assignments were made to the different officers to take immediate steps to secure the acceptance of men who were suggested as chairmen of the various committees, and to see that with the aid of these chairmen the committees will be organized and put to work as quickly as possible. The committee reports include:

(1) Scheduling locomotives through the shop for classified repairs; committee chairman, F. B. Downey, assistant shop superintendent, Chesapeake & Ohio, Huntington, W. Va.

(2) Training and coaching of supervision.

(3) Forging and heat treating of locomotive parts.

(4) Roundhouse problems caused by long runs and high speed, and the facilities for handling them.

(5) Best methods of selecting proper machinery and tools for repairs to modern locomotives.

(6) High spots in machine shop practices.

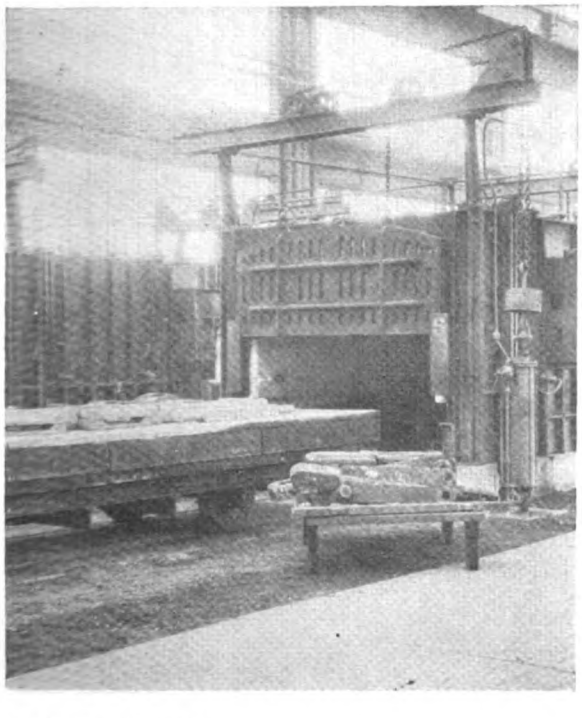
In addition to these reports it was decided to have two individual papers as follows:

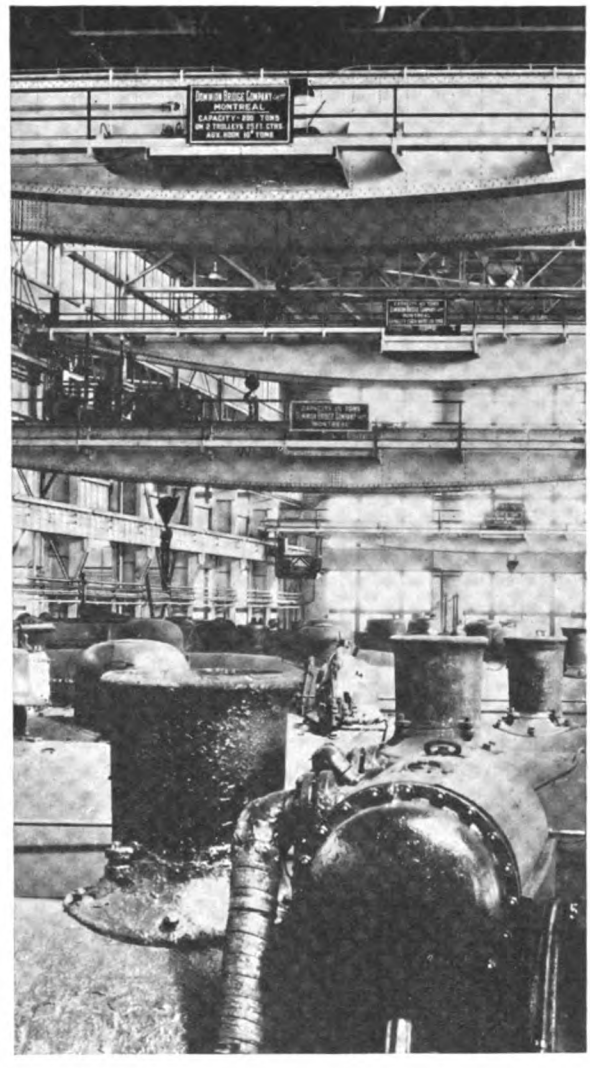
(1) Proper maintenance of modern locomotives, by D. S. Ellis, chief mechanical officer of the Chesapeake & Ohio; New York, Chicago and St. Louis, and Pere Marquette.

(2) Training of apprentices.

Two addresses by executive and operating officials are also scheduled on the program as follows:

(1) Training of supervisors, by L. W. Baldwin, chief executive officer, Missouri Pacific Lines.



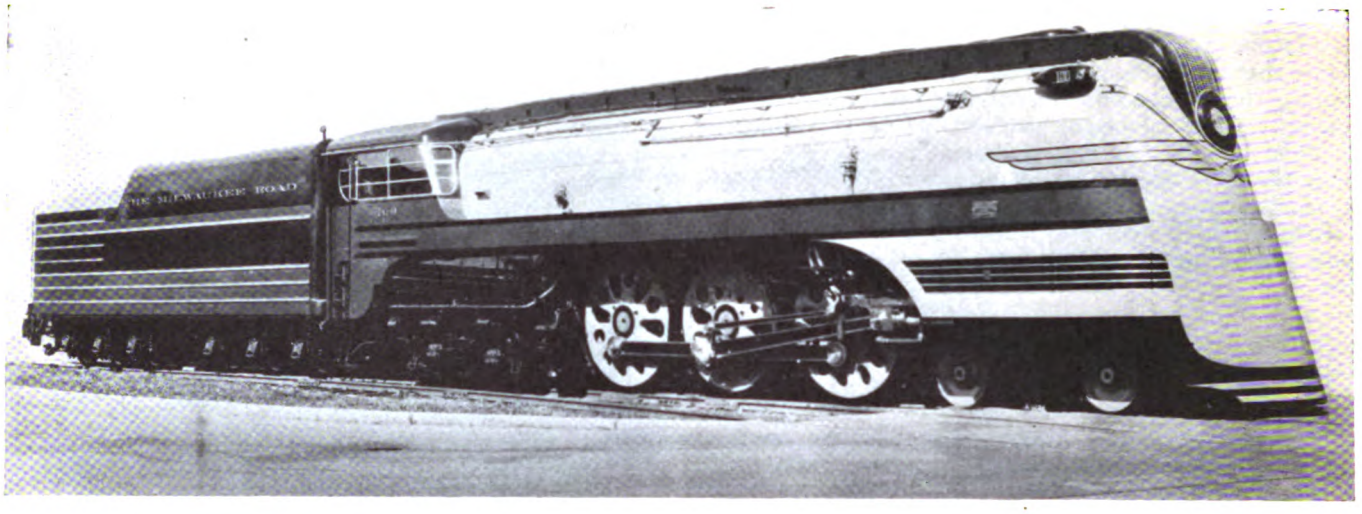


(2) Problems involved in high speed and modern operating practices.

Other features of the program will be a discussion of the association's activities, including changes in the constitution and by-laws to cover its new set-up, together with plans to establish it on a more substantial basis for future functioning.

In order to encourage closer contacts with the Mechanical Division, A. A. R., and to insure the maximum co-operation from the higher mechanical officers, it was decided to ask several of them to serve as an advisory committee, the members of this committee to review the proposed program and to assist in developing the organization along lines which will make its efforts most helpful and effective.

The officers of the association as elected last year and who will hold office during the present year are: President, F. B. Downey, assistant shop superintendent, Chesapeake & Ohio, Huntington, W. Va.; first vice-president, J. W. Oxley, general car foreman, Chicago & North Western, Maywood, Ill.; second vice-president, C. C. Kirkhuff, general foreman, Atchison, Topeka & Santa Fe, Chicago; third vice-president, J. C. Miller, general foreman, New York, Chicago & St. Louis, Conneaut, Ohio; fourth vice-president, J. E. Goodwin, general foreman, Missouri Pacific, North Little Rock, Ark.; secretary-treasurer, F. T. James, general foreman, Delaware, Lackawanna & Western, Kingsland, N. J.; chairman of the executive committee, J. B. Dunlop, Canadian National Railways, Leaside, Ont.



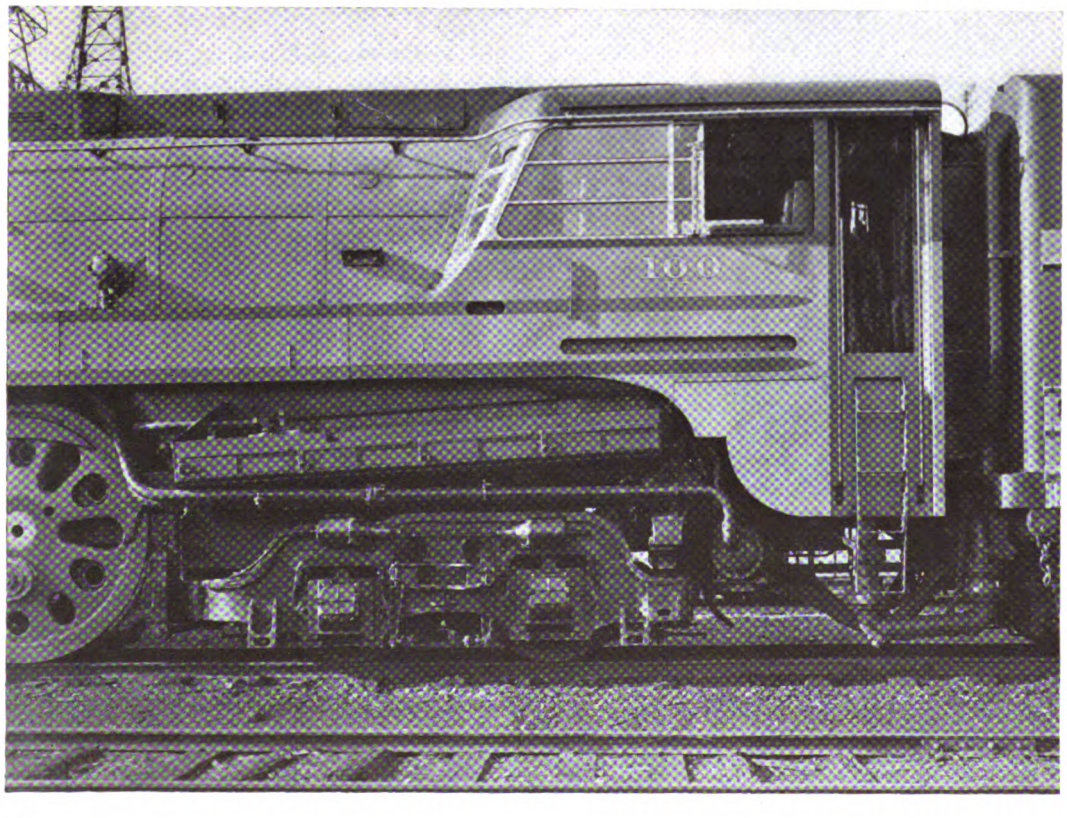
Distinctive Design Features 4-6-4 Type

Milwaukee Locomotives

Passenger motive power designed for heavy service develops tractive force of 50,300 lb. and weighs 415,000 lb. — Boilers have welded fireboxes

In August the American Locomotive Company delivered, from its Schenectady, N. Y., plant, six 4-6-4 type heavy passenger locomotives for service on the Chicago, Milwaukee, St. Paul & Pacific. While the new locomotives follow the general appearance of the original Hiawatha they are not solely for service on that train, but will be used on the Olympian and Pioneer Limited trains between Chicago and Minneapolis, a distance of 418 miles, and west of Minneapolis on the Olympian, to Harlowton, Montana, a distance of 914 miles. In the development of this "speedlined" design, Otto Kuhler, consulting engineer of design, collaborated with the railroad company and the builders.

These locomotives develop a tractive force of 50,300 lb. with a boiler pressure of 300 lb. and 84-in. driving wheels. The tenders carry 20,000 gallons of water and 25 tons of fuel.



The vestibule cab is of distinctive design and has a window arrangement which provides unusual visibility

Machinery Details

The foundation of these locomotives is a General Steel Castings Corporation's engine bed in which the cylinders, back cylinder heads, center plates, air reservoirs, link support, guide-yoke brackets, expansion-shoe pads, air-pump brackets and driver-brake fulcrums are cast as an integral part of the bed. The boiler is supported at the front and back of the firebox on expansion shoes, at the cylinders and by a waist sheet between the first and second pair of drivers.

The engine trucks are the General Steel Castings four-wheel type with 36-in. Davis cast-steel wheels, A. S. F. clasp brakes and Timken roller bearings. The driving wheels have Boxpok centers, 84-in. tires and Timken roller bearings. The journal diameter is 13½ in. at the main wheel and 12½ in. at the front and back. The Alco lateral-motion device is installed on the front pair of drivers.

The trailing truck is the Delta four-wheel type with centering device, furnished by the General Steel Castings Corporation with 38-in. Davis wheels at the front and 44-in. steel-tired wheels at the rear of the truck. The trailer wheels are equipped with A. S. F. roller-bearing units and clasp brakes.

The cylinders are 23½ in. bore by 30 in. stroke. Walschaert valve gear controlled by an Alco type H reverse gear actuates the 12-in. piston valves. The cylinder and valve chamber bushings are of Hunt-Spiller gun iron. The Z-type pistons are of rolled steel and both pistons and valves are fitted with Hunt-Spiller Duplex packing rings. Those on the pistons are the locked-lip type which require no bull ring and the valve rings are sectional bronze and iron.

The piston rod is of medium carbon steel, normalized and tempered, and is 5 in. in diameter. The crosshead and guides are of the multiple-bearing type. The main and side rods are of low-carbon nickel steel normalized, quenched and tempered. Floating bronze bushings are used at all pins with Hunt-Spiller fixed bushings in the rods. The crank pins are medium carbon steel and the main pin is hollow-bored.

The revolving weights at all wheels are cross-counterbalanced. The total weight of the reciprocating parts on each side is 1,681 lb.; the overbalance is 196 lb. on each wheel. The dynamic augment at 84 m. p. h. is 9,400 lb. in each wheel.

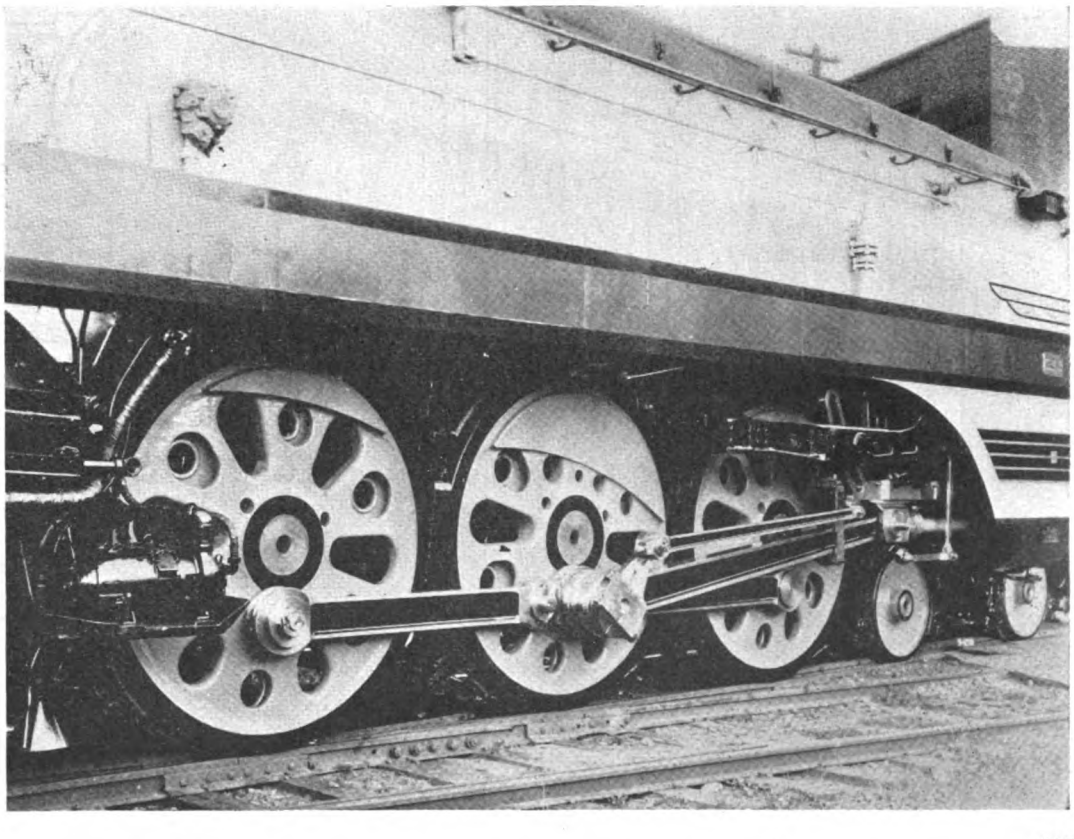
The Boilers

The boilers on these locomotives are built in three courses, the middle or dome course being conical in form. The inside diameter of the first course is 82½ in. and the outside diameter of the third course is 94 in. The thickness of the plate in the first course is ⅞ in. and $^{31}/_{32}$-in. plates are used in the second and third courses. The three barrel courses, welt strips and dome liner are silico-manganese steel having a maximum tensile strength of 82,000 lb. The front tube sheet is ¾ in. thick and the back tube sheet is ⅝ in. thick. The firebox is $96^{3}/_{16}$ in. wide by $144^{15}/_{32}$ in. long. The height from the bottom of the mud ring to the top of the crown sheet is 73½ in. at the rear and $88^{13}/_{16}$ in. at the front. The water space is 5 in. at the sides and back and 6 in. at the front of the firebox. The length of the combustion chamber is 44½ in. The roof and sides of the firebox are of silico-manganese steel similar to that used in the barrel course.

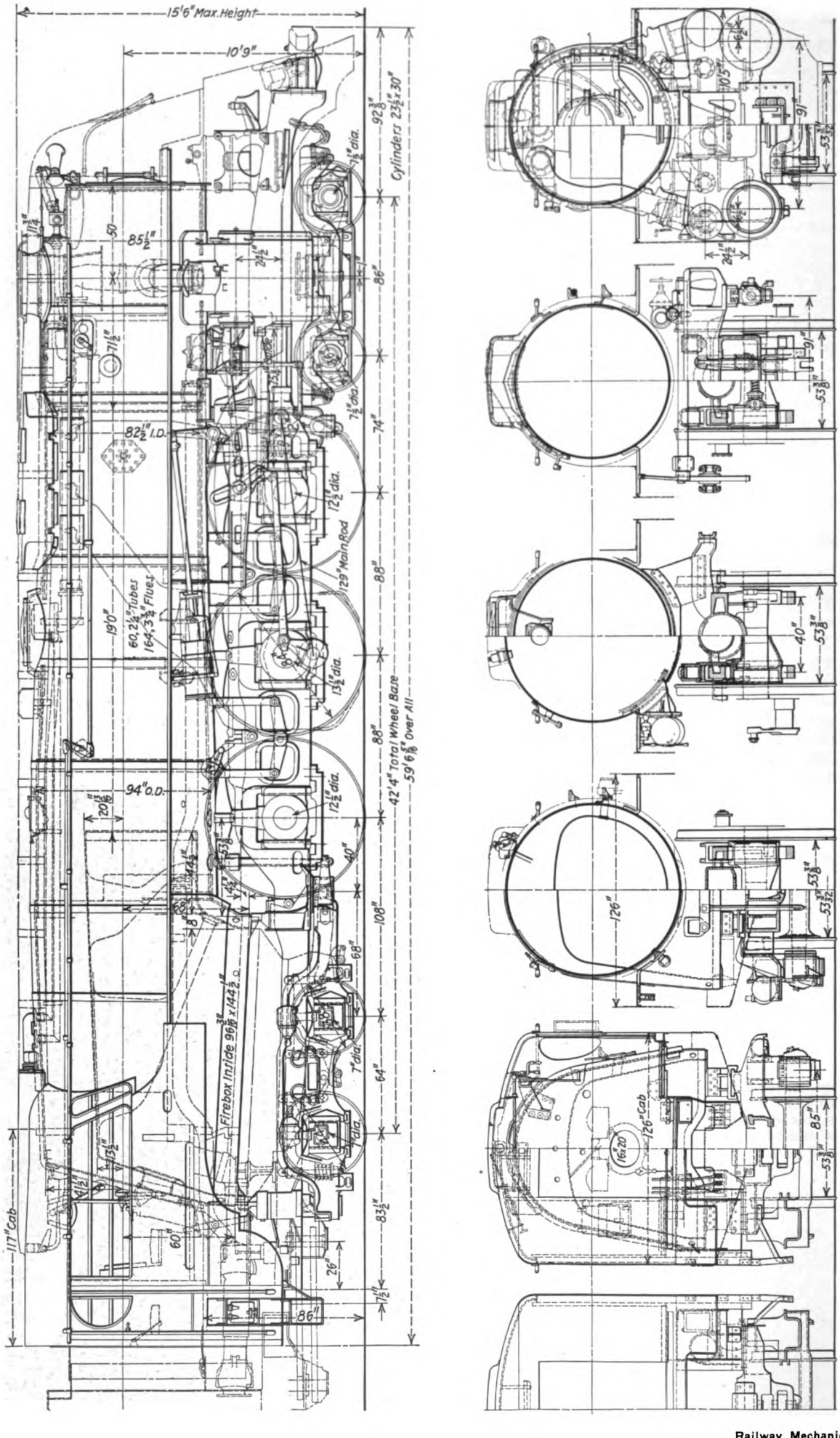
The roof sheet is $^{13}/_{16}$ in. thick while the outside side sheets are $^{9}/_{16}$ in. thick. The inside firebox sides and crown consist of three $^{13}/_{32}$ in. sheets welded together. Two Thermic syphons are located in the firebox, and a third one on the center line of the boiler is in the combustion chamber. In addition to the two syphons in the firebox, there are two 3½-in. arch tubes which, together with the syphons, support the American brick arch.

The boilers are fitted with sixty 2¼-in. tubes and one-hundred-sixty-four 3¾-in. flues. The length over the tube sheets is 19 ft.

The firebox is arranged for bituminous coal using Firebar grates. The grate area is 96.5 sq. ft. Coal is



The design of the streamline shrouding is such that the running gear is completely exposed



Elevation and cross-section of the Milwaukee 4-6-4 type passenger locomotive

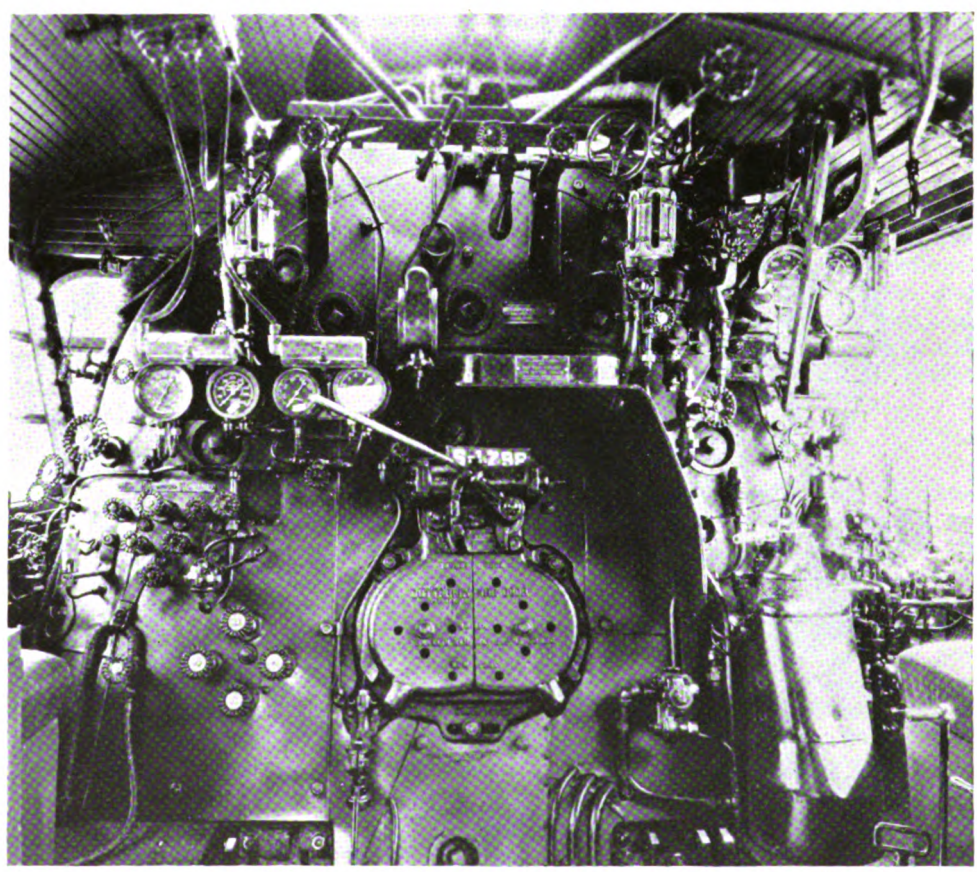
fed by means of a Standard modified type B stoker. The ash pans are of welded steel plate with cast-steel hoppers.

The fireboxes of these locomotives are completely welded. The firedoor flange, inside door sheet, inside throat sheet and back tube sheet, as well as the longitudinal seams which join the crown and inside firebox side sheets are welded butt joints.

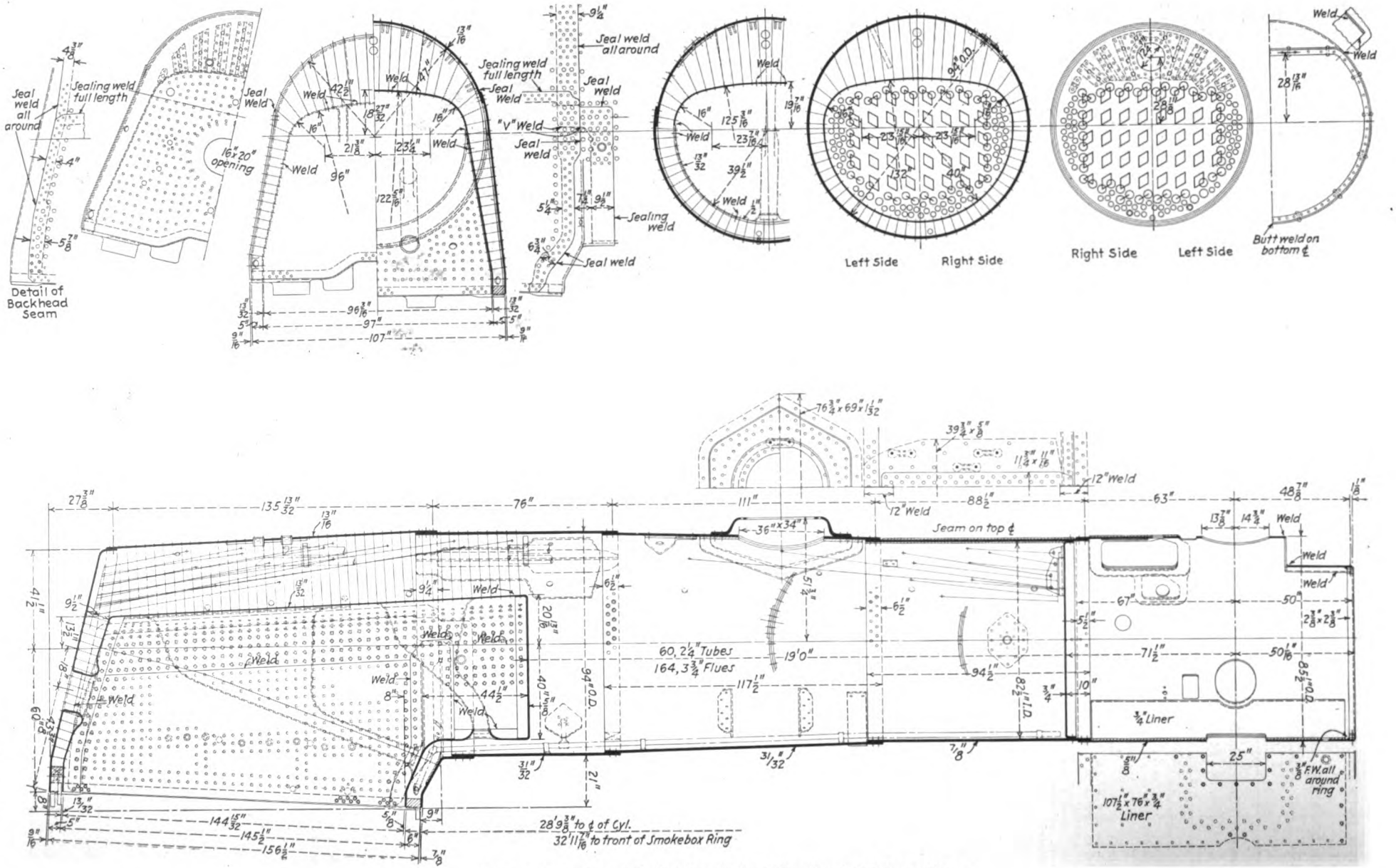
Alco flexible stays have been used extensively. Flexible expansion stays of the WZ type are used in the first six rows across the front of the combustion chamber. Two rows of flexible radials of the WY type are used at the edge of the crown sheet. WZ type sleeves

General Dimensions, Weights and Proportions of the C. M. St. P. & P. 4-6-4 Type Locomotives

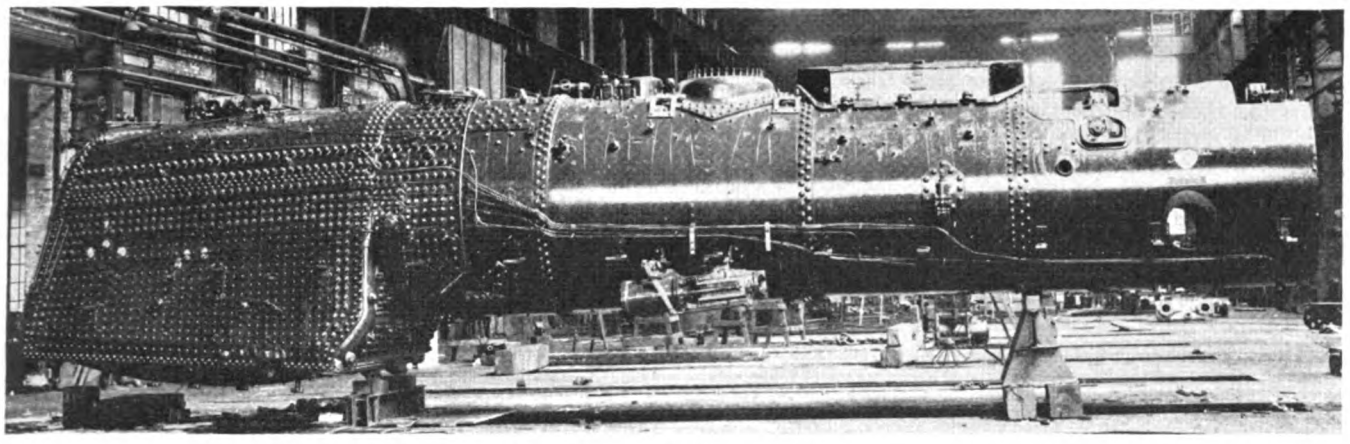
Railroad	C. M. St. P. & P.
Builder	American Locomotive Co.
Type of locomotive	4-6-4
Road class	F-7
Road numbers	100-105
Date built	1938
Service	Passenger
Dimensions:	
Height to top of stack, ft.-in.	15- 3
Height to center of boiler, ft.-in.	15- 6
Width overall, ft.-in.	10- 6½
Cylinder centers, in.	91
Weights in working order, lb.;	
On drivers	216,000
On front truck	82,500
On trailing truck:	
Front	53,000
Back	63,500
Total engine	415,000
Tender	375,000
Wheel bases, ft.-in.:	
Driving	14- 8
Rigid	14- 8
Engine, total	42- 4
Engine and tender, total	89- 10
Wheels, diameter, outside tires, in.:	
Driving	84
Front truck	36
Trailing truck:	
Front	38
Back	44
Engine:	
Cylinders, number, diameter and stroke, in.	2-23½×30
Valve gear, type	Walschaert
Valves, piston type, size, in.	12
Maximum travel, in.	7½
Steam lap, in.	1 1/16
Exhaust clearance, in.	¼
Lead, in.	5/16
Cut-off in full gear, per cent	84
Boiler:	
Type	Straight top
Steam pressure, lb. per sq. in.	300
Diameter, first ring, inside, in.	82½
Diameter, largest, outside, in.	94
Firebox length, in.	144½
Firebox width, in.	96 5/16
Height mud ring to crown sheet, back, in.	73½
Height mud ring to crown sheet, front, in.	88 3/16
Combustion chamber length, in.	44½
Arch tubes, number and diameter, in.	2- 3½
Thermic syphons, number	3
Tubes, number and diameter, in.	60- 2¼
Flues, number and diameter, in.	164- 3¾
Length over tube sheets, ft.-in.	19- 0
Fuel	Bituminous
Grate area, sq. ft.	96.5
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	348
Arch tubes	19
Thermic syphons	91
Firebox, total	458
Tubes and flues	3,708
Evaporative, total	4,166
Superheating	1,695
Combined evap. and superheat	5,861
Tender:	
Type	Rectangular
Water capacity, gal.	20,000
Fuel capacity, tons	25
Trucks	6-wheel
Rated tractive force, engine, lb.	50,300
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	52.1
Weight on drivers ÷ tractive force	4.29
Weight of engine ÷ evaporation	99.6
Weight of engine ÷ comb. heating surface	70.8
Firebox heat. surface, per cent comb. heating surface	78.1
Tube-flue heat. surface, per cent comb. heating surface	63.3
Superheat surface, per cent comb. heating surface	28.9
Firebox heating surface ÷ grate area	4.75
Tube-flue heating surface ÷ grate area	38.4
Superheat. surface ÷ grate area	17.6
Comb. heat. surface ÷ grate area	60.8
Evaporation ÷ grate area	43.2
Tractive force ÷ grate area	521.0
Tractive force ÷ evaporation	12.1
Tractive force ÷ comb. heating surface	8.58
Tractive force × diameter drivers ÷ comb. heating surface	721.0



The cab window arrangement of these locomotives provides a well lighted interior



Boiler cross-sections and elevation of the Milwaukee 4-6-4 locomotives



One of the boilers ready for the erecting floor

and caps are used for the flexible water space stays in the combustion chamber as well as a complete installation in the throat sheet. WZ type flexible water space stays are used in the breaking zones of the side and back head. There are four 2-in. combustion flues on each side of the firebox.

The boilers are equipped with the Barco type F3a low-water alarm, Wilson sludge remover together with Wilson blow-off cocks and muffler. Franklin butterfly type firedoors, Superior flue blowers and T-Z smoke consumers constitute part of the equipment.

Saturated steam passes through a Tangential steam dryer in the dome, through a 10-in. diameter steel dry pipe to an American multiple throttle built into the header of the Type E superheater.

Cab and Auxiliary Equipment

The brake equipment on these locomotives consists of the Westinghouse No. 8ET schedule with two 8½-in. cross-compound compressors. The main reservoirs are cast as part of the engine bed and have a capacity of 55,000 cu. in. The braking ratio on the engine truck is 45 per cent, on the drivers 60 per cent, and on the trailer 43 per cent. The engine truck brakes are operated by two 10-in. by 8-in. cylinders, the driver brakes by two 16-in. by 10-in. cylinders and the trailer brakes by four 8-in. by 8-in. cylinders. The train-control equipment is the Union Switch & Signal two-element type with three-indication cab signals. The locomotives are fitted with Valve Pilot speed recorders.

The air compressors are mounted under the streamline shrouding just back of the pilot. The air-compressor exhausts, together with the exhaust from the feedwater-heater pump, enter a header on the outside of the smokebox which is connected to a tunnel on the inside of the smokebox. The upper end of this tunnel discharges into a cavity cast integral at the rear of the stack. The generator is on a cast-steel bracket back of No. 3 driver on the right side.

The generator and headlight equipment were furnished by the Pyle-National Company.

The main cab turret is just forward of the cab under the cowling. It is connected inside the boiler with two 3-in. pipes leading from the dome. Saturated steam from this turret is supplied to the flue blowers, cab heaters, stokers, injectors, water conditioner and steam heat. Superheated steam is supplied to the whistle, air pumps and generator from a separate turret.

The cab is of the vestibule type, of welded copper-bearing steel, wood lined and insulated with Hairinsul. A recess in the exterior of the cab sides provides a toe hold for passing from the cab to the running board. Steam radiators have been installed on both sides of the cab and in the gangway. There are two seats, with Spongex cushions, on either side and drop seats are mounted on the rear vestibule wall on both right and left sides.

The metal cab-window sash were supplied by the O. M. Edwards Company and have shatter-proof glass in all sash.

On the front of these locomotives is a Buckeye type E folding coupler with a 6-in. by 8-in. shank. The Franklin Type E2 radial buffer is installed with the Unit Safety drawbar. Barco flexible connections are used between the engine and tender.

Lubrication

Mechanical lubricators supply the force-feed oil lubrication. A Nathan DV5 26-pint lubricator on the right side distributes oil to the valves and cylinders as well as the stoker and air pumps. A five-feed lubricator of 24 pints' capacity on the left side distributes oil to the driving boxes and guides. Three of the locomotives in this order have Detroit lubricators on the left side and the other three have Chicago lubricators. Both lubricators are driven from connections at the top of the combination levers.

Pressure grease lubrication is used extensively. Altogether 236 Alemite fittings are used on the engine and tender. The engine truck has 27 fittings, the crossheads, guides, motion work and reverse gear 42 fittings, the trailer truck 21 fittings, and the tender truck 58 fittings. Additional fittings on lubricator drives, valve-stem and crosshead guides, throttle rigging, motion, side rods and crank pins, spring and brake rigging, and wheels and boxes total 74 fittings. Rex fittings are used at 12 points on the driving boxes.

Streamlining

The streamlining on this locomotive follows the general theme of the first Hiawatha locomotive as far as the front end is concerned, which is at an angle of 16 deg. to the vertical. Every effort was made to adapt the form of the shrouding to established structural lines.

The front of the streamline shrouding opens at the center line on concealed hinges, giving access to the smokebox front, whistle and air-horn mountings. The air pumps are on either side of the front end behind the pilot skirting and are accessible through hinged side panels in front of each cylinder. A removable panel gives access to the hinged-type coupler. There is a grille above the headlight in front of the whistle and horn. This grille is made up of flat rolled-steel bars

with the narrow edge to the front trimmed with Snap-on stainless steel molding. These metal-trimmed bars are arranged in such a manner that the headlight remains the focal point of the front "face" of the locomotive. The original Hiawatha wing ornament has been retained in a somewhat modified form. This ornament is of stainless steel with a satin finish. The front hand rails are fitted to follow the lines of the headlight and wings and thereby become a part of the ornamentation. The road name is attached to the pilot skirting in stainless steel letters.

The pilot skirt is continued around the cylinders for aerodynamic and protective reasons and in order to accentuate the appearance of height and power rather than of width. The ornamental panel of the side cylinder skirting is continued forward so as to be visible from the front. In order further to relieve the appearance of bulkiness, the pilot skirting merges to a point at the bottom.

While the predominating color of the front end is gray, the horizontal striping of maroon and Milwaukee orange yellow as applied to the skirting below the running board has been continued around to the front in the same manner as the black-and-metal-striped panel on the cylinder skirting. On the bottom of the pilot skirt a maroon design breaks up the appearance of width by following the front edge of the striped cylinder panel. In addition to the ornamental value, the colorful appearance of the front of the locomotive has a decided safety value inasmuch as it is possible to observe it at great distances.

The cowling of the stack, sandbox and dome ends in a fishtail shape on the cab. The unbroken contour of this cowling contributes to smooth smoke flow and obviates the necessity of smoke deflectors. This cowling has been painted black. To retain a distinctive characteristic of the steam locomotive, a streamline cap has been shrouded around the stack and a smoke fin blended into the silhouette. The marker lamps are of special design. The stainless steel side hand rail runs back from the marker lamps and follows the contour of the boiler jacket and cab. Streamline brackets secure the hand rail in place. Between the top cowling and the running board the shrouding follows the boiler contour lines and is painted gray. The throttle arm, injector checks and flue blowers have not been covered.

The cab is a decided departure from conventional design. Every effort was made to increase visibility. This has been achieved by a narrow steel corner post permitting an increase in the clear width of the front cab windows. The length of the cab is further emphasized by the use of aluminum sash with narrow horizontal mullions. By this means the glass area is greatly increased, providing a well-lighted cab interior. The vestibule cab door and window which furnishes unusual visibility follow streamline design of the sash.

Recognizing the public's interest in seeing the mechanism of the locomotive in action, the running gear has been exposed to full view by terminating the running board skirting above the tops of the drivers. The lower end of the running board drops down in a curve under the cab to the lower line of the tender and cars. Following the colors of the cars, the running board skirt has been painted in Milwaukee yellow with broad maroon skirts at the upper and lower edge. The wheels are painted gray with maroon rings around the ends of the axles on the hub, and the side, main and eccentric rods are highly polished with maroon in the channels. A chromium-plated builder's name plate is attached to the skirting at the cylinders and the name plate of the speedline designer has been applied below the builder's plate in the black cylinder panel.

The tender treatment follows the color arrangement of maroon and yellow characteristic of the new 1938 passenger equipment.

The Tender

The tender tank is of all-welded construction and is built up on a Commonwealth water-bottom cast-steel underframe. The water capacity is 20,000 gallons and the coal space carries 25 tons. The hot well for the Wilson feed-water heater is on the left side behind the coal space.

The tender trucks are of the equalized six-wheel Commonwealth type with 38-in. Davis wheels and A. S. F. roller-bearing units. A. S. F. clasp brakes are used with 14-in. by 10 in. brake cylinders mounted inside on each truck. The braking ratio is 80 per cent.

The steam-heat connectors at the rear end of the tender are the Vapor flexible metallic type. The draft gear is the Miner velvet action passenger gear with Buckeye Type E coupler and yoke.

* * *



A good job of smoke prevention—Erie suburban locomotives stored at Jersey City, N. J., with fires banked

Master Boiler Makers' Association Meeting

(*Continued from page 415*)

fire as thin as possible over the entire grate surface. (3) Keep the firebox and front end in good condition, free from leaks, and clean flues when necessary. (4) Firebox sheets, tubes and flues should be kept free from scale. (5) The locomotive should be properly drafted.

Report by A. W. Novak

It has been said that leaky flues and fireboxes are chiefly responsible for the honeycombing and slagging. This is not true in all cases for I have seen cases of flue sheets honeycombing to the extent that 60 per cent of the flues were completely covered over with honeycomb from 1½ in. to 2 in. in thickness; nevertheless, no leaks existed in firebox or flues. After honeycomb was removed, inspection of flues showed them to be in clean condition, the front end was drafted according to standard practice and inspection during water test showed no leaks, nor were any air leaks found after the locomotive engine was fired up. Again, I have seen cases of flues and fireboxes leaking, as well as leaks in front end, where no honeycomb adhered to flues and tubes. Therefore, as above stated, firebox leakage is not in all cases responsible for the troublesome deposits on flue sheet commonly known as honeycomb. However, firebox leakage, improper drafting and other characteristics will aid materially in the honeycombing when certain grades of coal, which could be termed objectionable, are used.

Report by B. C. King

Slag contains iron in some form combined with a percentage of silicon and ash. The formation of slag is developed by any condition that retards combustion, causing temperature changes which will not produce enough heat to convert the mineral particles of fuel into nonfusible substances.

Honeycomb differs from slag inasmuch as the iron content is lower, with increase in the percentage of silicon and ash, and is caused chiefly by any condition that shortens the time element of combustion.

The fusing point of ash and clinkers may be divided into three stages: The initial point, the softening point, and the fluid point. For different fuels any decrease in temperature after fluidity has been attained will naturally tend to affect the density and hardness of the clinker.

The rate of burning has a definite bearing on the percentage of clinker formation in ash. The highest percentage of clinker formation has been found to occur at a rate of burning of 20 to 30 lb. of coal per sq. ft. per hr. The quantity of clinker decreases as the burning rate increases, although density and fusion are greater at higher rates. The rate of decrease of quantity of clinker becomes less for low ash-fusion temperature. Escape of gases through prolonged high temperature permits the formation of less brittle clinker.

The presence of iron in pyritic form or lime, in sufficient quantity, causes honeycombing or slagging. Coals with high iron content and low fusion point present the greatest problem.

Pyritic iron undergoes a chemical change at 800 to 900 deg. F. becoming ferrous sulphite. It adheres to small pieces of unburned fuel and is carried along by the draft and thrown against the surface of side sheets, staybolts and flue beads in semiplastic condition. Then heat drives off the volatile and combustible matter, leaving ash as honeycomb.

High percentage of iron or lime in the coal causes melting points as low as 1,800 to 2,000 deg. F., while alumina and silica raise the melting point from 2,600 to 3,000 deg. F. High silica and alumina ash are not readily fusible and usually ash low in iron and lime has high silica and alumina. Coal high in sulphur will generally clinker easily, and from this will form honeycomb and slag.

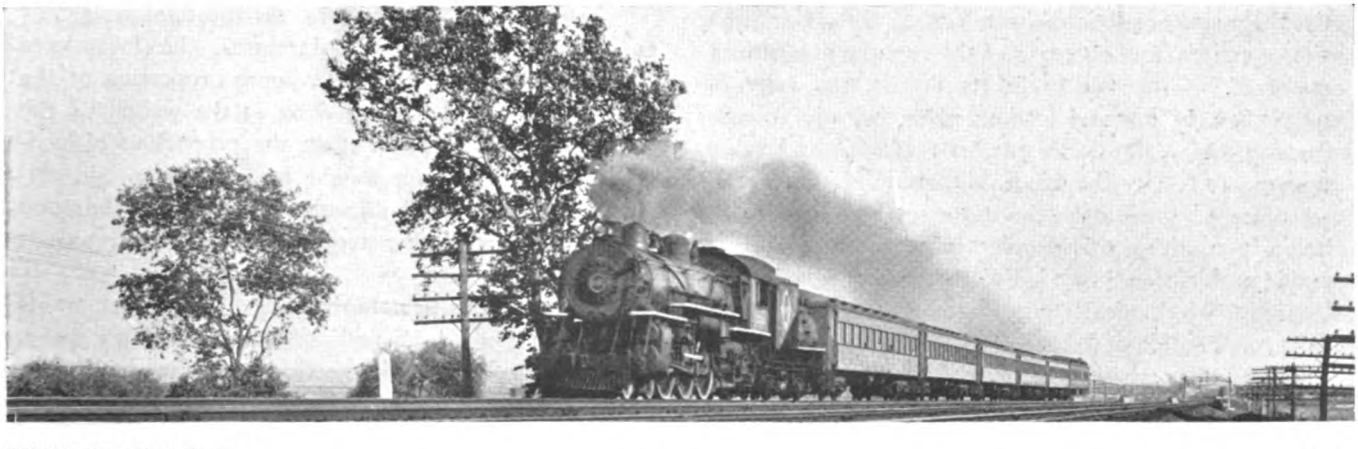
Causes of slag and honeycombing are leaky superheater units, leaks in firebox or flues, mud and scale in the boiler on firebox sheets or flues, holes in brick arch, defective grates with uneven openings for air admittance, improperly drafted front ends, air leaks in the front end, and stack out of line.

The prevention must consist first of keeping up maintenance so that there will be no leak of any kind either in the front end or firebox, and second, keeping up repairs to valve and cylinder rings to prevent an excessive demand for steam beyond the economical capacity of production.

Another preventive which has come under my observation is to lower the arch at the back end, making the arch as flat as possible, and to run the bricks as close to the door sheet as possible. This arrangement will entirely consume the iron in pyritic form and heat up the lime so that the honeycombing and slagging is lessened and will not adhere to firebox surfaces.

In conclusion I recommend that the design of power should contain more grate area and more firebox area to consume the fuel which becomes plastic. This can be accomplished by longer combustion chambers, and also by a flatter and longer brick-arch surface, leaving only sufficient opening between arch and door sheet to withstand the heat at the door; such an opening should be as near as possible to 120 per cent of the flue opening.

* * *



EDITORIALS

Car Officers Association Makes Real Progress

At the annual meeting of the Car Department Officers Association, held September 27-28 at Chicago, reported elsewhere in this issue, the total registration of members and guests was 191, this attendance being secured in an off-year with no exhibition of equipment and supplies to act as a drawing card and in spite of heavy pressure to curtail traveling expenses. The program included a total of ten committee reports which presented, in the aggregate, a large amount of information designed to increase the efficiency of car department operation. In general, the outstanding feature of the entire meeting, aside from the practical character of most of the reports, was the very pointed and pertinent discussions, which in some instances took more time than the reading of the original reports. These discussions were eloquent testimony to the value of the reports and the importance of the subjects under consideration.

The best answer to any question which might be raised regarding the potential importance of the Car Department Officers Association and the very real progress it is making may be obtained by a study of its proceedings. As pointed out in the report of its Publicity Committee, the 1937 meeting was considered sufficiently worth while that 1,150 copies of the proceedings were distributed, in addition to which abstracts of certain committee reports were widely publicized in the technical press. In the *Railway Mechanical Engineer* alone, for example, during the past year, almost 30 pages of editorials, news items and convention reports have been published, carrying valuable information, interesting news and doubtless some inspiration to car men throughout the country.

The Car Department Officers Association, through its regularly-elected officers, has repeatedly indicated its keen desire to supplement and in no way overlap the work of the Association of American Railroads, Mechanical Division, and experience indicates that with proper direction it should be entirely feasible to realize this objective. Individual members of the association bring together from all parts of the country a wealth of experience in the multitudinous details, not only of interchange, billing and loading rules, but of car construction and maintenance methods which are far too numerous to receive the detailed attention of higher railway officers. Obviously, the more successful the association is in sifting this detailed information, analyzing specific problems and developing practical suggestions as a basis for Mechanical Division action, the greater will be the contribution of the association to railway progress.

Still another very important function of the Car Department Officers Association is in developing men and training them to think clearly and speak effectively. The Association's meetings should be a forum where all may be heard in the presentation of ideas some of which, classed as impossible today, may prove factual tomorrow. Recognizing the desirability of avoiding "steam roller" tactics in suppressing debate, and, on the other hand, stimulating full and free discussion of all pertinent subjects, however controversial, it must be recognized that in the long run the reputation and future growth of the association will depend upon how effectively it keeps its feet on the ground and develops recommendations on all car matters which are basically sound and practicable.

Weight and Power Ratios of High-Speed Trains

On another page in this issue, in the report on Steam Turbines and Diesel Locomotives, which was presented at the recent meeting of the Fuel and Traveling Engineers Association, is a table showing comparisons of several Diesel-electric and steam locomotives and modern high-speed passenger trains in which the ratio of locomotive weight to the total weight of the train and the total weight of train per horsepower (engine or indicated) is given. This table is of interest because it shows the effect of several factors in determining the final proportion of total weight which must be reserved for the locomotive and the effect of this weight on the total horsepower required for various operating conditions. These factors are the weight per horsepower of the locomotive ready for service, the number of cars and average weight per car, and the pounds of total train per horsepower of the locomotive. The latter figure is in some measure an indication of the top speed which can be attained from the locomotive hauling its train. The importance of high weight efficiency in a locomotive design, whether Diesel or steam, is clearly indicated. As the total weight of the train per horsepower decreases, the locomotive weight becomes a rapidly increasing proportion of the total train weight. A reduction in the weight of the cars does not materially affect the proportion of locomotive weight to train weight for a given weight efficiency. It therefore affects proportionally the total amount of horsepower required for a given weight—horsepower ratio.

It is interesting to note that few of the steam trains tabulated are proportioned for extremely high speed, several of them showing ratios of train weight per horsepower of over 600 lb. and only one having a ratio

of less than 500 lb., while only a few of the Diesel trains have weight-power ratios greater than 500 lb.

Modern Equipment Needed To Reduce Expenses

The experience of recent years has indicated that, with increasing competition of other forms of transportation, the prospects of adding greatly to the gross revenues of the railroads are not particularly bright, surrounded with some uncertainty even with an improvement in general business conditions. For this reason, it is of great importance that every opportunity be grasped to effect permanent and substantial reductions in the cost of operation.

As far as the mechanical departments are concerned, they are directly responsible for the largest single item of operating expense—steam locomotive repairs—and, indirectly have considerable control over the fuel expense. These two items of operating expense, plus the expenditures for freight and passenger car repairs, amounted in 1937 to over 550 million dollars.

There are, therefore, two avenues open over which the mechanical officers have considerable control, the cost of locomotive operation and the cost of car and locomotive maintenance. With 67 per cent of the steam locomotives in this country over 20 years of age, it is well recognized that, as rapidly as funds can be found to finance their purchase, the introduction of modern motive power will contribute immeasurably to substantial reductions in the expense for fuel and maintenance.

In these days of small equipment replacement programs, the shop and engine terminal supervisor is working against odds in his battle to reduce maintenance costs for, if for no other reason, the increasing age of motive power brings about increases in the unit costs of repairs while, at the same time, a similar condition with respect to machine tools and shop equipment is making it more and more difficult to turn out repair work as economically and efficiently as it could and should be done with modern equipment. It is a case where the cost of repairs is automatically increasing because of a condition that can only be remedied by the modernization of equipment and repair facilities.

Whatever may be the ultimate outcome of the wage controversy, it does not alter the fact that the railways must save money.

It would seem, therefore, the railroad managements have arrived at a point where they must make a decision as to the future course to be followed in order to assure that their properties may remain solvent. Fortunately, with respect to both locomotive equipment and the facilities with which they are maintained, the records of performance of such equipment as has been installed in the last five or six years, proves conclusively that substantial reductions in operating and maintenance costs can be made.

Symptoms or Coincidence?

Two locomotive boiler explosions which occurred during the past summer have attracted more than ordinary attention. These were the failures of the boiler of an articulated freight locomotive on the Northern Pacific which completely wrecked the engine and part of the train, and the dropping of the crown sheet of the boiler on a Pennsylvania passenger locomotive without separating the boiler from the frames and, indeed, without derailing or stopping the locomotive and train until they had proceeded for several miles. Both failures were caused by low water and a contributing cause in each case was the partial ineffectiveness of the boiler feeding apparatus.

The firebox of the Northern Pacific locomotive was of unusual size; the crown sheet measured 26 ft. 9 in. in length. The evidence indicates that the water level had fallen only about 1 in. below its highest point at the time the crown sheet dropped. In the case of the Pennsylvania locomotive the water level apparently had dropped 5½ in. below the highest point on the crown sheet.

The number of such accidents and the resulting casualties have shown a gratifying reduction since the boiler inspection law first became effective in 1911. For the fiscal year ended June 30, 1912, there were 856 accidents caused by the failure of some part or appurtenance of the steam locomotive boiler. In these accidents 91 persons were killed and 1,005 injured. During the fiscal year ended June 30, 1937, there were 63 accidents, in which 19 persons were killed and 73 injured. Not all of these are low-water accidents, but most of the casualties, particularly the deaths, are associated with that type of accident.

It is probably too much to expect that the time will ever come when there will be a complete absence of crown-sheet failures. Considered in the light of this probability, the significance of these two accidents does not lie in the fact that the crown sheets failed, that the failures resulted from low water or, indeed, that each was the cause of loss of life. It lies in the fact that in each case during a considerable period immediately preceding the accidents the records show that repeated reports had been turned in by the enginemen on the improper functioning of the feedwater apparatus.

Following the Northern Pacific accident examination of the feedwater feeding equipment disclosed the fact that the packing ring of the drifting-control-valve piston was missing. The leakage of steam past the piston of this valve, the purpose of which is to cut down the speed of the hot-water pump when the locomotive is standing or drifting and automatically to cause it to operate according to the opening of the pump throttle when the locomotive is working steam, may result in the piston remaining stationary or not moving sufficiently to permit the full steam flow to the pump, thereby decreasing its capacity. During the 17 days prior to the accident eight separate reports indicating that the

water pump was unable to supply the boiler were made by seven different enginemen. In each case the record indicates that repairs or examinations of the water pump were made. In one case the engineman apparently suspected the nature of the defect and asked for examination of the drifting control valve and the float to the water pump. In his report of the investigation Chief Inspector Hall of the Bureau of Locomotive Inspection says that "the reduced capacity of the boiler feed pump caused by a defective drifting control valve was a contributing factor."

During a period of approximately one month prior to the failure of the crown sheet on the Pennsylvania locomotive six reports by three enginemen all indicate that one or both of the injectors failed to supply the boiler or fully to take up the water. Examination following the accident showed that the two injectors were so installed that with the steam-valve handles in the full open position the steam valves were actually something less than fully open, thus producing a condition in which the injectors were much more liable to break than would normally be the case. The temperature of the water in the tank indicated that one of the injectors, with the overflow valve closed, had broken and had blown steam back into the tank for some time.

The facts in both cases indicate complete futility on the part of the maintenance forces in their attempts to locate these repeatedly reported defects which ultimately were the cause of, or at least contributed to, destructive crown-sheet failures resulting in the death of seven persons and jeopardizing the lives of many others. Can these failures to make effective repairs be attributed to a certain callousness resulting from traditional differences of viewpoint between engine crews and enginehouse forces? We are reluctant to believe so. And yet it would seem that a repetition of reports in a matter so vitally affecting safety would cause an uneasy foreboding in the enginehouse which would not be relieved until the underlying cause of repeated work reports had been discovered and removed. Are not two widely separated cases of the failure or ineffectiveness of such an attitude a possible warning that budget trimming is beginning to exceed the limits of safety?

Welding Engineers Are Needed

It is generally recognized that welding of all kinds has made phenomenal strides in recent years in both the heavy goods industries and the transportation field. Electric and gas welding and cutting have revolutionized construction and maintenance methods in the railway equipment field. Welding, however, like Topsy, has more or less just grown and there can be no question that its progress has been hampered and delayed to a certain extent by the lack of an adequate number of engineers with the specialized training and experience essential in developing designs which employ the maximum economic use of modern welding methods. Moreover, the technique of welding is in such a state of flux and constant improvement that only the most alert and well-read students of the welding art can hope to keep abreast of the times.

A fact, sometimes overlooked, is that civil, mechanical, metallurgical and other engineers each have a rather definite and well-recognized vertical field of activity, whereas the welding engineer operates in what might be termed a horizontal field, cutting directly across all of the others. For example, a mechanical engineer well able to design welded joints and distribute stresses properly among the members of a given structure frequently lack the knowledge of how the welding operation might affect the properties of the metal involved, which is a problem in the field of metallurgy. In this connection, it is interesting to note that, among others, Ohio State University has just announced a new course of study leading to a degree in welding engineering which will embrace all branches of modern welding and endeavor to give men a special training in this new technology to supplement the other engineering courses.

All training and development work along this line should be encouraged and it is equally important that those engineers of design, particularly in the railway field, who have long since passed their period of formal schooling, start delving into the literature and practical application of modern welding practice, thus familiarizing themselves with the technique of the art so that full advantage may be taken of its possibilities without stumbling over any of its limitations.

New Books

QUESTIONS AND ANSWERS ON BRAKE EQUIPMENT. *The Air Brake Association, 3416 Empire State building, New York. Book No. 9—No. 8-ET Locomotive Brake Equipment, 75 cents; Book No. 10, "AB" Freight Car Brake Equipment, 75 cents; Book No. 11, "AB-8" Automatic Empty and Load Freight Car Brake Equipment.*

Book No. 9 contains over 300 questions and answers covering new developments and operating characteristics of the improved ET equipment as designed for service on modern locomotives. Book No. 10 contains questions and answers on the new standard brake equipment developed for long trains in modern high-speed freight service. Book No. 11 is supplementary to Book No. 10. It contains questions and answers on the new equipment which automatically changes the braking force when a car is more than half loaded or less than half loaded, and covers only the devices that are used in addition to standard AB equipment. In Books 9 and 10 are descriptions of the parts making up the No. 8-ET and AB equipment, respectively, as well as diagrammatic views of their application in various positions. The AB valve diagrams are in color.



This picture will be available for showing at Railroad Clubs and other Technical Group meetings after November 1st, 1938.

The Story of the

CHILLED CAR WHEEL

A talking motion picture which shows, graphically, how Chilled Car Wheels are made, and conducts the observer step by step through the test requirements now prescribed and enforced by the Association Inspection Department—including the aid rendered by one of the finest laboratories in the industry, jointly solving problems to insure a uniformly high-mileage product.

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High Spots in

Railway Affairs . . .

The Supervisor and Safety

The National Safety Council celebrated its silver jubilee in Chicago last month. In addressing the Steam Railroad Section, John E. Long, superintendent of safety of the Delaware & Hudson and a past-president of the Council, stressed the vital importance of the supervisors as key men in insuring safe operation. "They should have the ability to detect unsafe practices and correct them before the accident happens," said Mr. Long. "Just because an operation has been performed many times without an accident," he continued, "does not imply that it is a safe method; many accidents are caused by following presumably safe practices which were actually unsafe, but the hazards of which had not been detected. An accident is really a mistake coming to light. . . ." Then he made this significant statement: "Statistics show us that there are about 30 accidents to equipment or material to every one that even slightly injures a human being and that there are about 300 minor injuries on the average to one lost-time injury."

Against Wage Reduction

The emergency fact finding board appointed by President Roosevelt, and consisting of Chief Justice Walter P. Stacy of the North Carolina Supreme Court; Dr. Harry A. Millis, retiring chairman of the Department of Economics of the University of Chicago; and Dean James M. Landis of the Harvard Law School, finally made its report on Saturday, October 29. It should have been presented before midnight on Thursday, the 27th, but the board asked for additional time. It concluded "that no horizontal reduction upon a national scale of the wages of railway labor should be pressed by the carriers at this time." This conclusion was based upon the fact that it found that the wages of railway labor are not high as compared with those in other comparable industries. It concluded also that a horizontal reduction of wages on a national scale would not meet the financial emergency of the industry, since the savings would not be distributed merely to the needy roads. The board believes that the financial distress of the carriers is a short term situation and cannot be regarded as grounds for a wage reduction, especially in view of present indications of an improvement in the business of the carriers. It believes also that a wage reduction in the railroad industry would run counter to the trend of wage rates in industry generally.

Not So Many Fires

Like the National Safety Council, the Railway Fire Protection Association celebrated its silver jubilee in October. Since it was founded 25 years ago, fire losses on the railroads have been cut more than one-half, insurance rates have been reduced and the total yearly insurance premiums paid by the railroads have dropped about 75 per cent. There were 4,932 fires on the railroads of the United States in 1937 as compared to 5,998 in 1936, the total loss in 1937 being $3,750,707. Sparks or hot coals from locomotives caused 323 fires, with a loss of $101,284. Of the properties, box cars suffered the most, with 1,033 fires and a loss of $604,547. Car shops had 23 fires with a loss of $343,818.

Where Do We Go From Here?

The fact finding board has found against a reduction in railway wages. It is doubtful if the public would stand for further increases in freight and passenger rates, even if the Interstate Commerce Commission approved of them. The Administration and Congress have admitted the seriousness of the railway situation, for several years, but have done nothing constructive to remedy it. Committees of Congress which have had to do with the railroad problem have spent their time investigating matters which in their minds were open to criticism, but have failed to face the railroad question in a large way; indeed, they have not even attempted to take any constructive action. Railroad labor leaders have advocated government ownership of the railroads and their actions generally have been such as to seriously lower the morale of the employees. Adequate railroad transportation is vital to the prosperity and best interests of the country. The railroad managements have done what they could to improve the services with the means at their disposal. Now it is up to President Roosevelt and Congress. The responsibility cannot be further evaded! What will they do?

Train Accident Records Improve

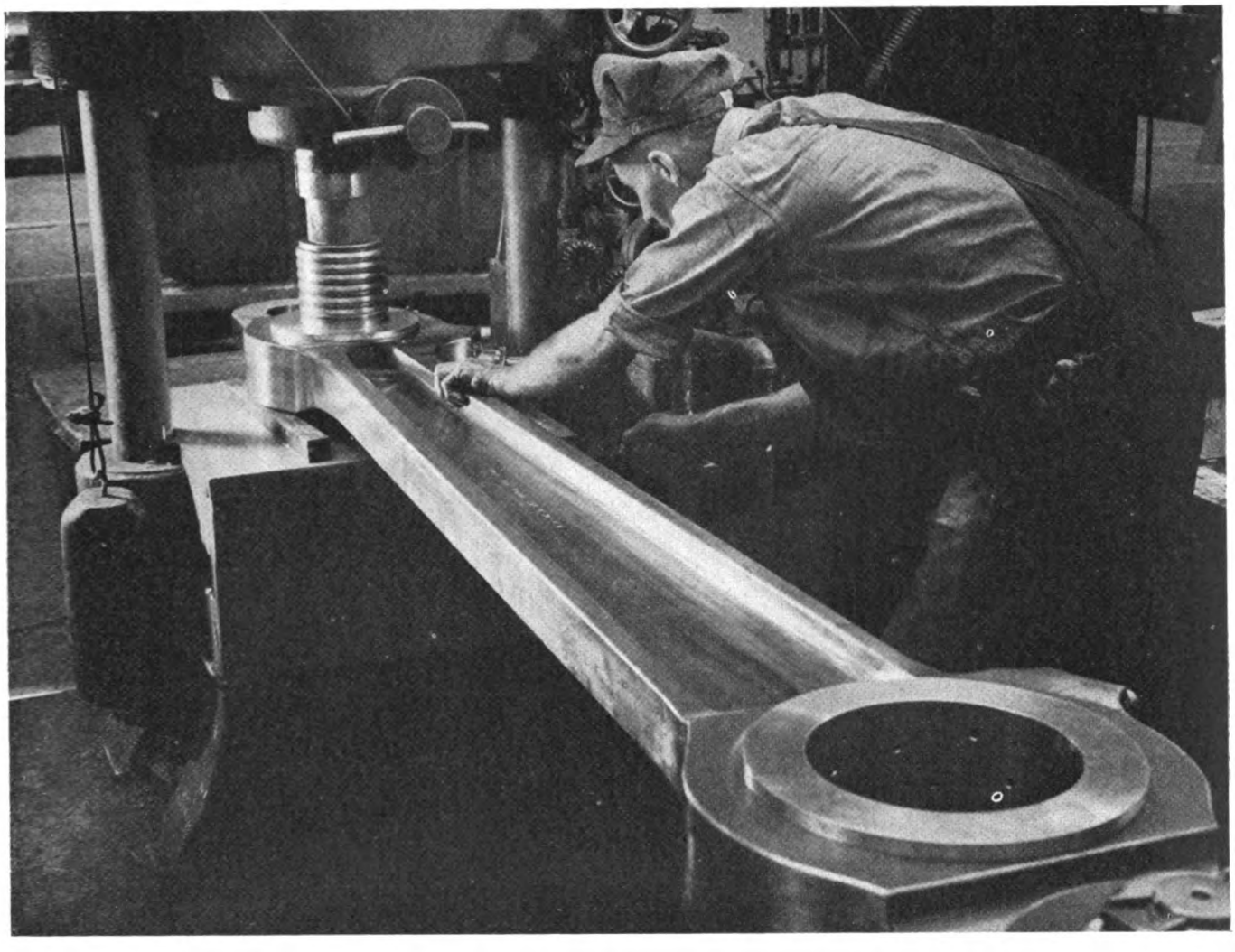
Accident Bulletin No. 106, recently issued by the Interstate Commerce Commission's Bureau of Statistics, shows that 5,350 persons were killed and 36,692 injured on the railroads during 1937; this compares with 5,398 killed and 34,706 injured in 1936. A special analysis of train accidents indicates that "the cause for the interruption in 1934-36 in the downward trend was the increase in accidents due to the condition of track or equipment, probably the result of decreased expenditures for maintenance in the years of low railway revenues." The tabulation of accidents from the standpoint of speed indicates that the greatest number of accidents occurred at speeds under 10 m.p.h., but in the aggregate, the greatest amount of property damage occurred at train speeds of 40 to 50 m.p.h., although the number of train-miles having no casualties may also have been greatest in this range. Reports made public by the Bureau of Railway Economics of the Association of American Railroads covering the first six months of 1938 show "the best general safety record ever established by the railroads for any similar period." Compared with the first six months of 1937 there was a reduction of 17.6 per cent in fatalities and 28.6 per cent in non-fatal accidents.

Digging Up Service Records Data

According to the terms of the Railroad Retirement Act, the railroads are required to bring up to date the service records of prospective pensioners. Arrangements have been made with the Works Progress Administration whereby furloughed railway employees eligible for W. P. A. work relief, will be assigned to railroad offices to do this work. The railroads will thus be relieved of this expense and when the work is completed the records will be in such shape that prompt action can be taken by the Retirement Board when applications are made for annuities. Railroad labor apparently will not object, provided the standard daily rate of wage is paid the workers and only furloughed railway employees are given the jobs. A. V. Vallandingham, assistant to comptroller, Delaware & Hudson, has been granted leave by that road in order to direct the project. The central office will be in Chicago and it is estimated that a W. P. A. appropriation of $18,000,000 will be required to create about 1,800,000 service files of individual records. The project as a whole will of necessity get under way slowly, because the W. P. A. requirements are such that a grant cannot be made upon a national basis, but must have the specific approval of each of the state directors as to the proposed set-up for their territories.

(*Turn to next left-hand page*)

METHODS AND MACHINERY THAT GUARD LIMA QUALITY



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After rod bushings are applied it is customary to finish them with a boring tool. » » » But this practice does not result in the perfect finish demanded at Lima. » » » Here a serrated mandrel is pressed through the bushing after finish boring. The mandrel is made with six steps, each larger than the other by .002″, the largest being exactly the size of the desired bore. » » » This method not only produces a smooth, accurate finish but the compression of the metal by the burnishing tool closes the grain, thereby providing a perfect wearing surface and a longer-lasting bearing.

LIMA LOCOMOTIVE WORKS LIMA LOCOMOTIVE WORKS INCORPORATED INCORPORATED, LIMA, OHIO

Among the Clubs and Associations

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Loss and Damage Prevention and the Car Man is the subject to be discussed by Joe Marshall, special representative, A. A. R., at the November 14 meeting to be held at 8 p. m. at the LaSalle Hotel, Chicago.

NORTHWEST CAR MEN'S ASSOCIATION.—"Some Wheel Shop Observations" was the subject discussed at the November 7 meeting by H. F. Ripken, wheel shop foreman, Minneapolis, St. Paul & Sault Ste. Marie.

NEW ENGLAND RAILROAD CLUB.—C. C. Warne, purchasing agent, New York Central, discussed Railroad Purchasing at the November 15 meeting held at the Hotel Touraine, Boston, Mass.

CENTRAL RAILWAY CLUB OF BUFFALO.—Two speakers addressed the meeting held on November 10. James G. Lyne, assistant to the editor, Railway Age, discussed "The Present Political Situation as Related to the Railroads," and Harry L. Nancarrow, superintendent, Pennsylvania Railroad, discussed the "Railroads—Their Benefit to the City of Buffalo."

A. S. M. E. to Hold Annual Meeting December 5-9

THE American Society of Mechanical Engineers will hold its 59th annual meeting at the Engineering Societies building, New York City, on December 5-9. Delegates from 71 local sections of the society located in the United States and Canada will meet to discuss ways and means of increasing the usefulness of this organization of 15,000 engineers to the individual member and his community.

The Railroad Division of the society, one of the 17 divisions each of which covers a specialized field in mechanical engineering, will bring a group of four papers to the meeting as follows: Counterbalancing of Reciprocating Weights in Steam Locomotives, by A. I. Lipetz, chief consulting engineer, American Locomotive Company; Electric Locomotives, by B. S. Cain, assistant engineer in charge of design, locomotive division, General Electric Company; Motive Power Characteristics and Lightweight Equipment, by R. Eksergian, Edward G. Budd Manufacturing Company; Annual Report of Progress in Railway Mechanical Engineering, by E. G. Young, Research professor, railway mechanical engineering, University of Illinois.

The first two of these papers will be presented at the morning session on Thursday, December 8 and the latter two will be presented at the afternoon sessions of the same day. At 6:30 p. m. will be held the annual dinner of the Railroad Division.

Tuesday, December 6

Afternoon

POWER—FUELS

Report of Boiler Feedwater Studies Committee, by C. H. Fellows

ELASTICITY—APPLIED PROBLEMS AND MECHANICAL SPRINGS (I)

Stresses in Helical Compression Springs, Present Status of the Problem, by C. T. Edgerton
Analysis of Effect of Wire Curvature on Allowable Stresses in Helical Springs, by A. M. Wahl
A Method of Calculating Energy Losses During Impact, by C. Zaener and H. Feshbach

Evening

Honors Night

Wednesday, December 7

Morning

OIL AND GAS POWER

Five Years' Progress of Oil and Gas-Power, by H. E. Degler
The Vectorscope—A new instrument useful in the solution of problems pertinent to study and design of internal-combustion engines, by G. J. Dashefsky

METAL-FORMING PROCESSES

The Effect of the Speed of Stretching and the Rate of Loading upon the Yielding of Mild Steel, by E. A. Davis
Tension Devices in Rolling Strip, by Morris Stone
The Forces Required for Rolling Strip Under Tension, by A. Nadai

Afternoon

ELASTICITY—APPLIED PROBLEMS AND MECHANICAL SPRINGS (II)

Deflection of Helical Springs under Transverse Loadings, by W. E. Burdick, F. S. Chaplin and W. L. Sheppard
Strength of Metals, with Special Reference to Spring Materials, by D. J. McAdam, Jr., and R. W. Clyne
Research Report on Helical Springs, by C. T. Edgerton

LUBRICATION

Thin Oil Films, by Walter Claypoole
Wear in Lubrication Problems, by L. M. Tichvinsky

Evening

Annual banquet and President's reception, Astor Hotel

Thursday, December 8

Morning

RAILROAD

Counterbalancing of Reciprocating Weights in Steam Locomotives, by A. I. Lipetz
Electric Locomotives, by B. S. Cain

Afternoon

EDUCATION AND TRAINING

The Cost of Apprenticeship, by Warner Seely
Industrial Training in the Air-Conditioning Industry, by Ray D. Smith

RAILROAD

Motive-Power Characteristics and Lightweight Equipment, by R. Eksergian
Annual Report of Progress in Railway Mechanical Engineering, by E. G. Young

Evening

Railroad dinner

Chicago Car Men Elect Officers

AT the annual meeting of the Car Foremen's Association of Chicago, on Friday evening, October 7 at the LaSalle hotel, the following officers were elected for the ensuing year: president, P. B. Rogers, car shop superintendent, Atchison, Topeka & Santa Fe, Chicago; first vice-president, W. J. Healion, superintendent of shops, North American Car Corporation, Blue Island, Ill.; second vice-president, C. A. Erickson, general A. A. R. inspector, Chicago & North Western, Chicago; treasurer, C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, Chicago; secretary, G. K. Oliver, assistant passenger car foreman, Baltimore & Ohio Chicago Terminal, Chicago.

Retiring President F. A. Shoulty was elected to the board of directors which now comprises the following: Chairman, P. B. Rogers, Atchison, Topeka & Santa Fe.; F. A. Shoulty, Chicago, Milwaukee, St. Paul & Pacific; F. L. Kartheiser, Chicago, Burlington & Quincy; William Hartnett, Chicago & North Western; W. A. Emerson, Elgin, Joliet & Eastern; J. S. Acworth, General American Transportation Corporation; C. W. Broo, New York, Chicago & St. Louis; C. O. Young, Illinois Central; F. R. Callahan, Pullman Company; R. R. Hawk, Wilson Car Lines; A. E. Smith, Union Tank Car Corporation; K. A. Milar, Milar & Company; and W. J. Demmert, Griffin Wheel Company.

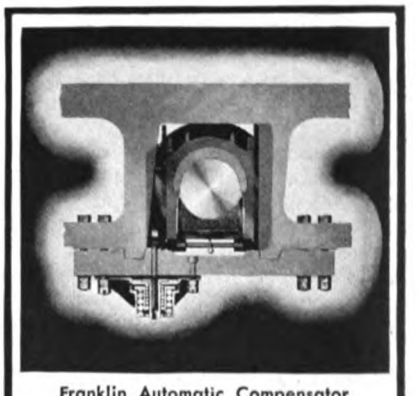
A. S. M. E. Elects 1939 Officers

THE American Society of Mechanical Engineers elected the following new officers for 1939, who will assume office on December 9: President—A. G. Christie, professor of mechanical engineering, Johns Hopkins University, Baltimore, Md.; Vice-presidents—H. H. Snelling, Snelling & Hendricks, Washington, D. C.; W. L. Dudley, vice-president in charge of design and sales, Western Blower Company, Seattle, Wash.; A. Iddles, application engineer, Babcock & Wilcox Company, New York; James W. Parker, vice-president and chief engineer, Detroit Edison Company, Detroit, Mich.; Managers—C. Freeman, vice-president in charge of fire prevention engineering & underwriting, Manufacturers Mutual Fire Insurance Company, Providence, R. I.; William H. Winterrowd, vice-president, Franklin Railway Supply Company, Chicago, Ill., and W. R. Woolrich, dean of engineering, University of Texas, Austin, Tex.

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Differences in driving box temperatures of as much as 250° in short periods of time result in hand-adjusted driving box wedges being either too loose or too tight. » » » The solution is the Franklin Automatic Compensator and Snubber. With this application, accurate adjustment is constantly maintained . . . while the locomotive is running. » » » Any expansion or contraction that occurs in the driving box is automatically taken up. In addition, abnormal shocks are taken care of by a heavy outer spring that acts as a cushion. » » » For constant, accurate adjustment, easier riding, prevention of pounds, and reduced tire wear, incorporate Franklin Automatic Compensators and Snubbers.



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NEWS

Soo Line Locomotives—A Correction

In the list of materials and equipment on the Minneapolis, St. Paul & Sault Ste. Marie locomotives on page 364 of the October issue of the *Railway Mechanical Engineer* it is incorrectly stated that the steam-heat regulator was furnished by the Vapor Car Heating Company. The regulator is of the Leslie type.

Side Frame Welding Rule Extended

The Board of Directors of the Association of American Railroads has extended to January 1, 1940, the effective date of revisions of Interchange Rule 3, Sec. t-3, Rule 19 and Rule 23, Sec. *II, III,* and *IV,* which revisions are contained in Supplement No. 2 to the 1938 Code of Interchange Rules, and are designed to prohibit the welding of L- and T-section cast steel side frames when such frames fail.

Former L. M. S. Mechanical Officer Dies

Sir Henry Fowler, who was chief mechanical engineer of the London, Midland & Scottish (Great Britain) between 1925 and 1930, died on October 16 at the age of 68. After an apprenticeship with the Lancashire & Yorkshire he entered the employ of the Midland in 1900 and became chief mechanical engineer in 1909. After the grouping of this company with the London, Midland & Scottish, Sir Henry became chief mechanical engineer of the L. M. S. in 1925. In 1930 he was appointed assistant to the vice-president for works.

P. R. R. Shopmen Reject A. F. of L. Unions

Shopmen on the Pennsylvania voted to reject seven craft unions of the American Federation of Labor and designated the Brotherhood of Railroad Shop Crafts of America, Pennsylvania System as their collective bargaining agent, according to an announcement by the National Mediation Board. The designated union, which is unaffiliated with either the A. F. of L., or the C. I. O., won by a vote of 17,003 to 10,934 when votes from 13 states and the District of Columbia were counted. The balloting also revealed that the accepted union had won the election in every craft.

Wages and Hours Law Effective October 24

Railroad employees generally came within the minimum-wage provisions of the wages and hours law when that act became effective on October 24. The carriers, along with other transport agencies subject to the Interstate Commerce Act, are exempt from the maximum-hours provisions. The minimum wage is fixed at 25 cents per hour for the first year of the law's operation; then it becomes 30 cents, and after six years, 40 cents.

It is not anticipated that the 25-cents minimum will affect any great proportion of railway employees. It is expected, however, that many questions of interpretation may arise before it is finally determined what railroad employees are involved; i. e. those actually engaged in interstate commerce. Like other industries the carriers are expected to have an industry committee to work in conjunction with Administrator Andrews, a matter which was before a recent meeting of the Association of American Railroads board of directors.

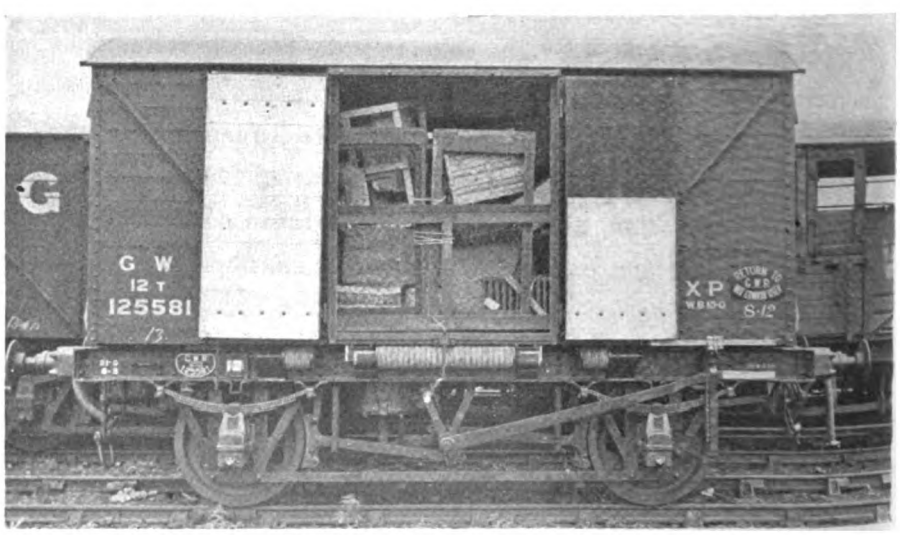
A. A. R. Tests Run at 102 M. P. H.

In the high-speed steam passenger locomotive tests with a 1,000-ton 16-car train, conducted by the Association of American Railroads over the lines of the Pennsylvania, the Chicago & North Western and the Union Pacific, speeds up to 102 m.p.h. were attained, and a large amount of information not heretofore available was secured regarding locomotive performance and train resistance in the upper-speed ranges. These tests were conducted for the A. A. R. Committee on Further Development of the Reciprocating Steam Locomotive, of which D. S. Ellis, chief mechanical officer, Chesapeake & Ohio, is chairman, details of the tests being under the direct supervision of W. I. Cantley, vice-chairman of the committee and mechanical engineer of the A. A. R. Mechanical division.

Test runs were made both east and westbound, on the lines of the Pennsylvania between Ft. Wayne, Ind., and Chicago; on the Chicago & North Western between Chicago and Omaha, Neb., and on the Union Pacific between Omaha, Neb., and Grand Island. On the Pennsylvania, two Class K-4-S locomotives of the 4-6-2 type, built about 1924, were used, these locomotives having 44,000-lb. rated tractive force, 205-lb. boiler pressure, and 80-in. driving wheels. On the westbound run, a maximum speed of 90 m.p.h. was reached and all necessary test data recorded. When the train reached a point about five miles west of Warsaw, Ind., and was proceeding at a speed of about 87 m.p.h., a part of the indicator drive mechanism on the right side of the locomotive broke and dropped into the valve motion, causing the union link to fail, with resultant blowing out of the cylinder heads, both front and back, on the right side. The train came to a stop without other damage to the locomotive or track and, after a slight delay, it proceeded with another locomotive to Chicago. On the eastbound run, made the latter part of the same week, this test train attained a maximum speed of 91 m.p.h., on a slightly descending grade without unusual incident.

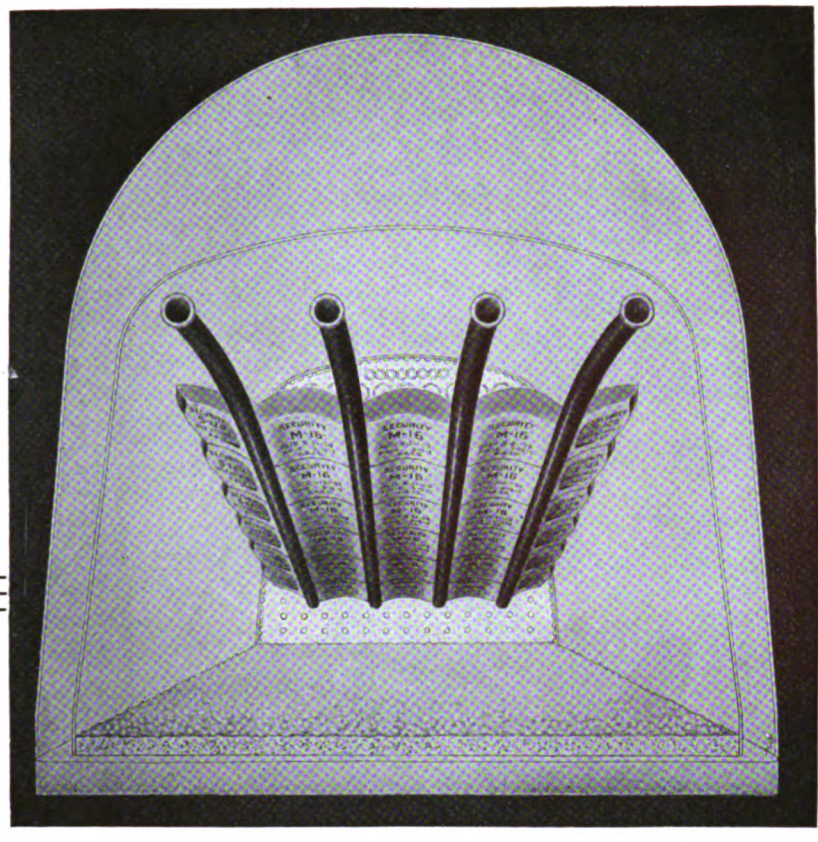
The test runs on the Chicago & North Western were made with a new streamline Class E-4 locomotive of the 4-6-4 type, having 55,000-lb. rated tractive force, 300-lb. boiler pressure, and 84-in. driving wheels. The locomotive on the westbound trip, equipped with 12-in. piston valves, reached a maximum speed of 95 m.p.h. The locomotive on the eastbound trip, with 14-in. valves, attained a maximum speed of 89½ m.p.h., both of these speeds being made on slightly descending grades.

(*Continued on next left-hand page*)



A 15-ton experimental shock-proof freight car of the Great Western of England

The car body is free to move longitudinally on the underframe under control of rubber springs. Switched against standing cars from speeds of 3.3 to 14 m.p.h., the body movement of the underframe varied from 1 in. to $13^{9}/_{16}$ in. Loaded with fragile, unclaimed freight—toys, furniture, lamp shades, glassware—breakage in the trials was confined to five thin-glass lamp shades, three tumblers out of a carton, and one chair leg.



ANYTHING
less than a complete arch
IS FALSE ECONOMY

To let the desire for reduced inventory result in a locomotive leaving any roundhouse without a full set of Arch Brick is poor economy. » » » Even a single missing Arch Brick will soon waste many times its cost in fuel and in locomotive efficiency. » » » To spend the fuel dollar efficiently, every locomotive Arch must be maintained 100%. » » » Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency may be maintained.

There's More to SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

On the Union Pacific tests, a modern 4-8-4 type steam locomotive about one year old was used, having a rated tractive force of 63,000 lb., a boiler pressure of 300-lb., and 77-in. driving wheels. The maximum speed attained on the westbound trip to Grand Island was 89 m.p.h., and eastbound on a slightly descending grade 102 m.p.h.

The objective in these tests, conducted with a single train of 16 Pennsylvania cars having known scale weights, was not primarily to compare the three individual types of locomotives tested, but rather to secure actual data regarding general locomotive characteristics essential in meeting most satisfactorily the requirements of modern operating conditions. As soon as the test data are analyzed and studied a formal test report will be released for the information of individual railroads as well as the locomotive builders.

The research project of which these road tests are part was begun in 1937 by the Mechanical Division of the Association of American Railroads, which appointed a special committee to develop a reciprocating steam locomotive capable of handling 1,000 trailing tons at 100 miles per hour on level tangent track. To accomplish this, it was felt that from 5,000 to 5,500 cylinder horsepower would be required. At that time, the group agreed as to the general lines along which such a locomotive should be developed, with reference to the boiler pressure, the steam temperature, the factor of adhesion, etc.

Members of the Committee on Further Development of Reciprocating Steam Locomotive other than Messrs. Ellis and Cantley are W. R. Hedeman, assistant to chief motive power and equipment of the Baltimore & Ohio; J. E. Ennis, engineering assistant of the New York Central; W. R. Elsey, mechanical engineer of the Pennsylvania; J. M. Nicholson, acting mechanical superintendent of the Atchison, Topeka & Santa Fe; Lawford H. Fry, railway engineer of the Edgewater Steel Company; W. E. Woodard, vice-president of the Lima Locomotive Works; Harry Glaenzer, vice-president of the Baldwin Locomotive Works; J. B. Ennis, vice-president of the American Locomotive Company; E. G. Bailey, vice-president of the Babcock & Wilcox Company, and Edward C. Schmidt, professor of railway engineering at the University of Illinois.

C. P. Shopmen Agree to Three-Week Shutdown

UNION leaders, representing approximately 13,000 shop employees of the Canadian Pacific, and executives of the road recently agreed upon a three weeks' complete shut-down of the main shops of the system throughout Canada. The agreement, effective October 24, was reached after a closed conference between company officers and representatives of the Shop Crafts Federation of the Canadian Pacific, and was made in preference to a reduction of working forces. Shop employees agreed that a general shut-down and the resultant spread in loss of wage earnings would be more equitable than partial lay-offs.

Roosevelt Picks Reed for Retirement Board

ACCEPTING the recommendation of the Association of American Railroads, President Roosevelt, on October 1, appointed M. Roland Reed, formerly superintendent of motive power of the Pennsylvania's Eastern Pennsylvania division, as the carriers' representative on the Railroad Retirement Board for a five-year term. Mr. Reed succeeds James A. Dailey whose term expired on August 28. Mr. Reed was nominated by the A.A.R., while 137 members of the American Short Line Railroad Association endorsed Mr. Dailey for reappointment.

Mr. Reed was born July 26, 1883, in Newton, Ill., and was graduated from Rose



M. R. Reed

Polytechnic Institute in 1905 with a B.S. degree in mechanical engineering. Meanwhile he had entered railroad service during school vacations as a laborer in the Terre Haute (Ind.) shops of the Pittsburgh, Cincinnati & St. Louis (now P. R. R.). After graduation he returned to those shops to serve for a few months as a signal repairman before becoming a special apprentice in the Union Pacific shops at Omaha, Nebr. Mr. Reed returned to the P. C. & St. L.'s Terre Haute shops as a draftsman in September, 1906, serving in that capacity for one year, and thence for two years as assistant foreman. He was chief draftsman from 1909 to 1917, and general car inspector on the Pennsylvania's Northwest System during the next two years. From 1918 to July, 1926, Mr. Reed was successively superintendent of car repairs, master mechanic on the P. R. R. Eastern and Logansport divisions and assistant general superintendent of motive power for the Northwest region. During 1926-28 he was acting master mechanic and master mechanic on the Fort Wayne division, after which he became, successively, superintendent of motive power of the Northern and the Eastern Pennsylvania divisions and general superintendent of motive power for the Central region. He returned to the position of superintendent of motive power, Eastern Pennsylvania division, at Harrisburg in December, 1936.

R. F. C. Equipment Loans

The Southern is contemplating an R. F. C. loan of $6,000,000 to finance the purchase of 2,400 freight cars under arrangements similar to those whereby it acquired 5,704 freight cars earlier this year.

The Boston & Maine is negotiating for a loan of $2,000,000 to replace equipment damaged in the recent hurricane.

The Seaboard is seeking $725,000 for a Diesel-electric locomotive and 7 coaches.

New York Central.—The Interstate Commerce Commission, Division 4, has modified its report and certificate of August 19, so as to permit the New York Central to use the proceeds of the $5,000,000 loan originally intended for the repair of 1,000 freight-train cars, for the repair of approximately 50 additional locomotives. The commission has also ordered that the number of units given in the statement of the purposes for which the proceeds of the loan may be used should be considered approximately rather than exact.

Rail Unemployment Insurance Chief

THE Railroad Retirement Board, on October 1, announced the appointment of James Gordon Robinson as Director of Railroad Unemployment Insurance to ad-

(*Continued on next left-hand page*)

New Equipment Orders and Inquiries Announced Since the Closing of the October Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
New York Central	20*	600-hp. Diesel-elec. switch	Electro-Motive Corp.
	9*	600-hp. Diesel-elec. switch	American Loco. Co.
Pennsylvania	25†	21,000-gal. tenders	Company shops

LOCOMOTIVE INQUIRIES

Alaska	1‡	4-6-2	.....
St. Louis-San Francisco	5	4-8-2	.....

PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Southern	20§	Express	Bethlehem Steel Co.

* Involve an expenditure of about $1,825,000, to be made in installments over a period of eight years.

† Approximate cost $550,000. For use with M-1 type freight locomotives.

‡ Inquiry renewed.

§ Subject to the approval of the I. C. C. as to the issuance and sale of securities to finance the cost.

NOTE: The Seaboard Air Line is making plans for the purchase of a new streamline train.

The Trend Is Towards Economical Injectors

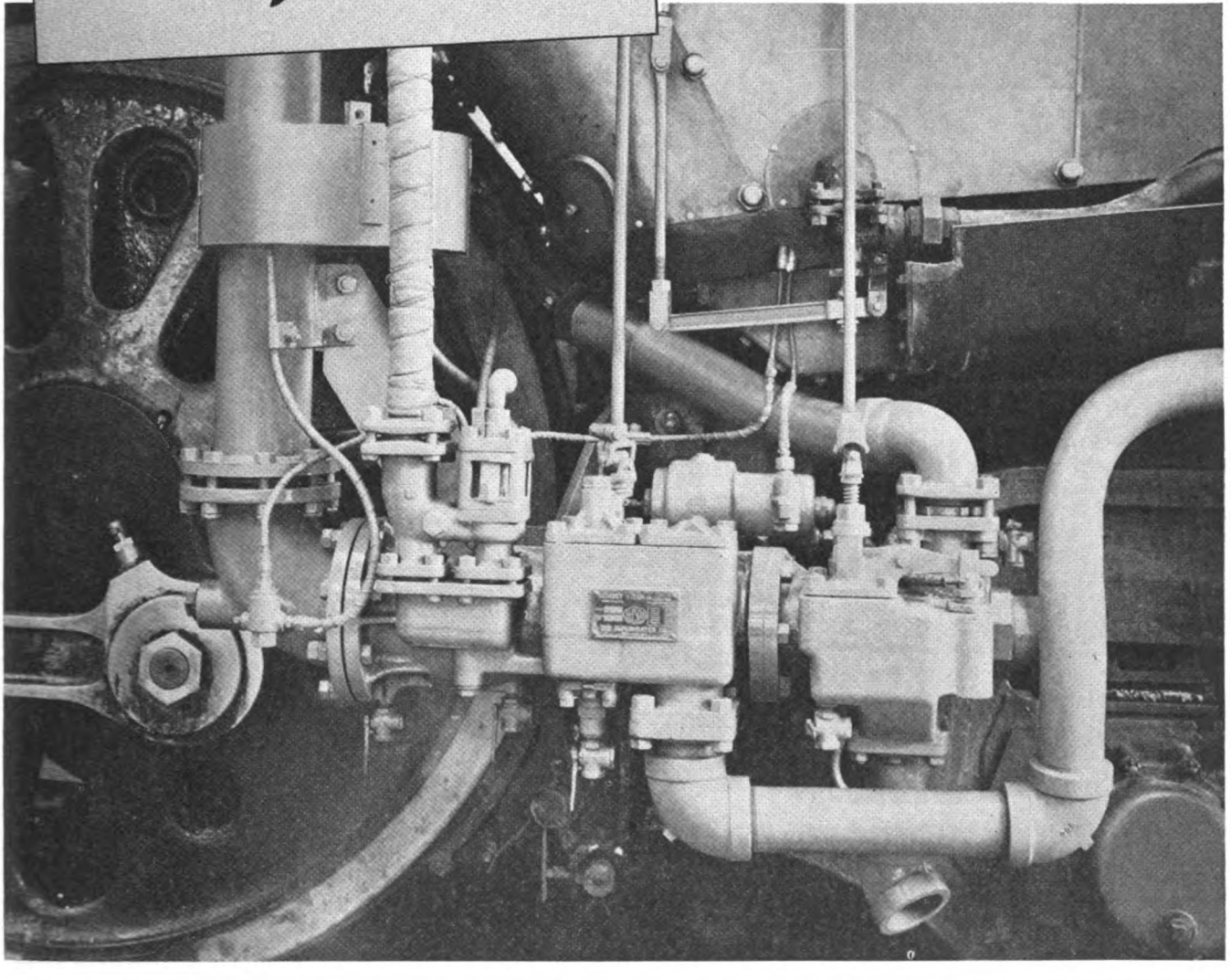
Elesco exhaust steam injectors use exhaust steam to both preheat and inject the feed water into the boiler.

The changeover from live steam to exhaust steam operation is entirely automatic.

Its operation is stable as the maximum amount of exhaust steam that can be condensed by the suction water is automatically admitted to the injector.

There are no constantly moving parts.

More than 20,000 injectors of this type have been applied to locomotives throughout the world.



ELESCO A-1272

THE SUPERHEATER COMPANY

Representative of AMERICAN THROTTLE COMPANY, INC.
60 East 42nd Street, NEW YORK 122 S. Michigan Ave., CHICAGO
Canada: THE SUPERHEATER COMPANY, LTD., MONTREAL

Superheaters • Exhaust Steam Injectors • Feed Water Heaters • American Throttles • Pyrometers • Steam Dryers

minister the new Railroad Unemployment Insurance Act which was passed at the last session of Congress. Mr. Robinson assumed his duties on October 3.

According to the Board's statement, Mr. Robinson has had a long career of experience as a consultant in private management and in public administration, as well as with the actual operation of unemployment insurance laws. His most recent experience in the latter field was as organizer and executive director of the Unemployment Compensation Commission of New Jersey. For about 15 years he has been associated with Griffenhagen & Associates, consultants in public administration and finance.

In an interview with the press after his induction into office, the new director said that his division, which will be a part of the Railroad Retirement Board, would employ about 1,000 persons from Civil Service rolls when the work gets into full swing. He expects to get the necessary machinery set up so that benefit payments can be paid after July 1, 1939. The director will receive claims for unemployment compensation prior to July 1, 1939, but no payments can be made until that date.

The Act, which Mr. Robinson will administer, creates a national pooled-fund system of unemployment insurance for railroad workers. As of July 1, 1939, it withdraws them from the coverage of Title IX of the Social Security Act and the state unemployment compensation acts. Contributions and benefits do not become payable until July 1, 1939. Contributions will be made by covered employers at the rate of three per cent of wages, excluding any amount in excess of $300 per month payable to any employee.

To become eligible for benefits an employee must (1) have earned $150, or more, from covered employment within the appropriate preceding calendar year and (2) have had, within six months preceding the beginning of a benefit year, a waiting period of fifteen consecutive days of unemployment, or two half months in each of which there were 8 days of unemployment.

Employees will be disqualified from the receipt of benefits for varying periods for such reasons as refusal to accept suitable work, voluntarily quitting work without good cause, discharge for misconduct, and other reasons.

Benefits, computed on a daily basis, will range from $1.75 to $3 per day in accordance with the amount earned during the base year. The maximum that an individual can receive during the benefit year is 80 times his daily benefit rate, the range thus being from $140 to $240.

Although the new law is founded on the same general philosophy as the unemployment insurance section of the Social Security Act, it is different in that the moneys collected from the railroads are to be "earmarked" for the Board's account and not placed in the Treasury's general fund as are the Social Security Board's funds. The Secretary of the Treasury may invest them, but he must not use them for paying other government bills.

Supply Trade Notes

W. I. Howland, Jr., vice-president in charge of western sales of the Carnegie-Illinois Steel Corporation, Chicago, has been transferred to Milwaukee, Wis., as manager of sales.

◆

James A. Bradley & Company, Chicago, have been appointed distributors for Youngstown Sheet & Tube Company's tubular products.

◆

Stanley H. Smith has been appointed railroad representative of the Gould Storage Battery Corporation in the Cleveland (Ohio) district, with headquarters at Cleveland.

◆

The Silent Hoist Winch & Crane Co., has moved its works and general offices from 762 Henry street to improved facilities at 841 to 865 63rd street, Brooklyn, N. Y.

◆

John R. Johnston, manager of sales of the Milwaukee district of the Carnegie-Illinois Steel Corporation, has been appointed assistant manager of sales of the Chicago district.

◆

William Sellers & Co., Inc., Philadelphia, Pa., manufacturers, since 1848, of machine tools, has engaged Clarke-Harrison, Inc., management engineers, to take charge of all the company's operations, including research, design, engineering, manufacturing and sales.

◆

Yale D. Hills has been appointed manager of distributor sales for the Service-sales Division of The Timken Roller Bearing Company. Mr. Hills' headquarters are at the main Timken factory at Canton, Ohio. For several years he has been manager of the Los Angeles, Cal., territory branch of the company.

◆

John A. MacLean, Jr., assistant to the president of the MacLean-Fogg Lock Nut Company, Chicago, has been elected president, to succeed John A. MacLean, deceased. Mr. MacLean, Jr., was born at Wilmette, Ill., on January 22, 1905, and



John A. MacLean, Jr.

graduated in civil and mechanical engineering from Sheffield Scientific School, Yale University, in 1927. The following year he went with the MacLean-Fogg Lock Nut Company as assistant to the president.

◆

Facilities of the USL Battery Corporation in Niagara Falls, N. Y., formerly devoted to the manufacture of batteries for railroad, industrial and utility service are now being utilized for automobile battery manufacture, and the company's industrial battery division is being discontinued. Arrangements have been made with the Gould Storage Battery Corporation, Depew, N. Y., to acquire the USL power battery department and to continue for USL customers complete inspection and replacement service covering USL industrial batteries now in the field.

◆

James A. King, vice-president in charge of production of the Morton Manufacturing Company, Chicago, has been relieved of his duties pertaining to factory operations and will hereafter devote his full attention and time to engineering and sales promotion including his personal supervision of sales to steam and electric railways and the bus industry in the central United States district.

Obituary

G. La Rue Masters, vice-president of the National Lock Washer Company, Newark, N. J., died on October 25, at his home in South Orange, at the age of 58 years.

◆

J. Donald Cunningham, a sales engineer of the Southern Wheel Division of The American Brake Shoe and Foundry Co., died at his home in Cleveland, Ohio, on October 7, after a short illness.

◆

John F. O'Connor, who retired as consulting engineer of W. H. Miner, Inc., Chicago, in 1930, died on September 28 of a complication of ailments. He was born in Ireland in 1864, and started work at the age of 15 as a machinist's helper for the New York, New Haven & Hartford. After holding the positions of machinist, and locomotive inspector, he became general

foreman of the enginehouse and shops at Providence, R. I., from which position he resigned to enter the employ of the Sterlingworth Railway Supply Company. Five years later, in 1904, he resigned to become mechanical engineer for W. H. Miner, Inc., and later was appointed consulting engineer. Mr. O'Connor had obtained approximately 1,000 patents, most of which covered draft gears and parts. Other patents covered snow plows, wrecking equipment and shop devices. One of the most important of these is a chronometer for measuring with extreme accuracy the reaction developed upon impact of two bodies at high speed, a device that has been of great help in measuring the stress to which draft gears are subjected.

Personal Mention

General

L. L. WHITE has been appointed vice-president of the Erie, with headquarters at Cleveland, Ohio, having supervision over purchases and development.

L. H. SCHEIFELE, tool and material inspector of the Reading, with headquarters at Reading, Pa., has been appointed engineer of tests, with the same headquarters, succeeding J. B. Young, deceased.

C. B. HITCH, assistant superintendent motive power of the Chesapeake & Ohio, with headquarters at Huntington, W. Va., has been appointed superintendent motive power at Richmond, Va., succeeding T. F. Barton, deceased.

E. D. HALL, chief chemist of the Erie, with headquarters at Meadville, Pa., has been appointed engineer of tests and chief chemist. C. P. BROOKS has been appointed assistant engineer of tests of the Erie with headquarters at Meadville, Pa.

F. A. BUTLER, superintendent motive power and rolling stock of the Boston & Albany, who retired on September 30 as announced in the October issue of the *Railway Mechanical Engineer*, was born on September 21, 1868, at Shrewsbury, Mass., and entered railway service on June 20, 1892, with the Boston & Albany as a locomotive fireman. He then became engineman and later worked in the enginehouse at Beacon Park, Allston, Mass. In May, 1908, he was appointed road foreman of engines and in July, 1910, became master mechanic of the Boston division. Mr. Butler was transferred in the latter capacity to the Albany division in November, 1916, and in January, 1924, was appointed superintendent motive power and rolling stock at Boston. The position of superintendent of motive power and rolling stock has been abolished.



F. A. Butler

THOMAS W. DEMAREST, general superintendent motive power of the Pennsylvania, at Philadelphia, Pa., who retired on September 1, was born on March 18, 1868, at Englewood, N. J., and was graduated from the Stevens Institute of Technology, Hoboken, N. J. He entered the service of the Pittsburgh, Cincinnati & St. Louis (P. R. R.) on August 1, 1889, as a special apprentice at Columbus, Ohio. From August, 1891, to February, 1896, he was assistant to superintendent motive power of the same road at Columbus, and from the latter date until February, 1897, was assistant to master mechanic at Indianapolis, Ind. Mr. Demarest served as general foreman locomotive department at Indianapolis from February, 1897, to August, 1899; master mechanic at Logansport, Ind., from August, 1899, to January, 1900; superintendent motive power from January, 1900, to July, 1903, all with the Pittsburgh, Cincinnati & St. Louis and its successor, the Pittsburgh, Cincinnati, Chicago & St. Louis (now Pennsylvania). He was superintendent motive power Northwest system, Pennsylvania Lines West of Pittsburgh, at Ft. Wayne, Ind., from July, 1903, until March, 1920, and from the latter date until June, 1925, served as general superintendent motive power, Northwestern region, Pennsylvania system, at Chicago. Mr. Demarest became general superintendent motive power of the Western region at Chicago in June, 1925, and general superintendent motive power of the Pennsylvania at Philadelphia in December, 1936. Mr. Demarest has a long record of distinguished service in various capacities with the A.A.R. Mechanical division and its predecessor, the Master Car Builders' Association, which he joined in 1900, becoming a vice-president in 1915. He was made a member of the Arbitration Committee in 1901 and served as chairman from 1924 to 1935, then relinquishing the chairmanship, but continuing on the committee until 1937.



T. W. Demarest

N. M. TRAPNELL, assistant to superintendent motive power of the Chesapeake & Ohio, at Richmond, Va., has been appointed assistant superintendent motive power with headquarters at Richmond, succeeding C. B. Hitch. The position of assistant to superintendent motive power has been abolished. A photograph of Mr. Trapnell and a biographical sketch of his railway career were published in the September issue of the *Railway Mechanical Engineer*.

Master Mechanics and Road Foremen

J. SHELABERGER, master mechanic of the Southern Pacific at West Oakland, Calif., retired on October 1.

A. C. SCHOEDINGER, assistant master mechanic of the Louisville & Nashville at Boyles, Ala., retired on September 1.

S. M. HOUSTON, assistant master mechanic of the Southern Pacific at West Oakland, Cal., has been promoted to master mechanic, succeeding J. SHELABERGER.

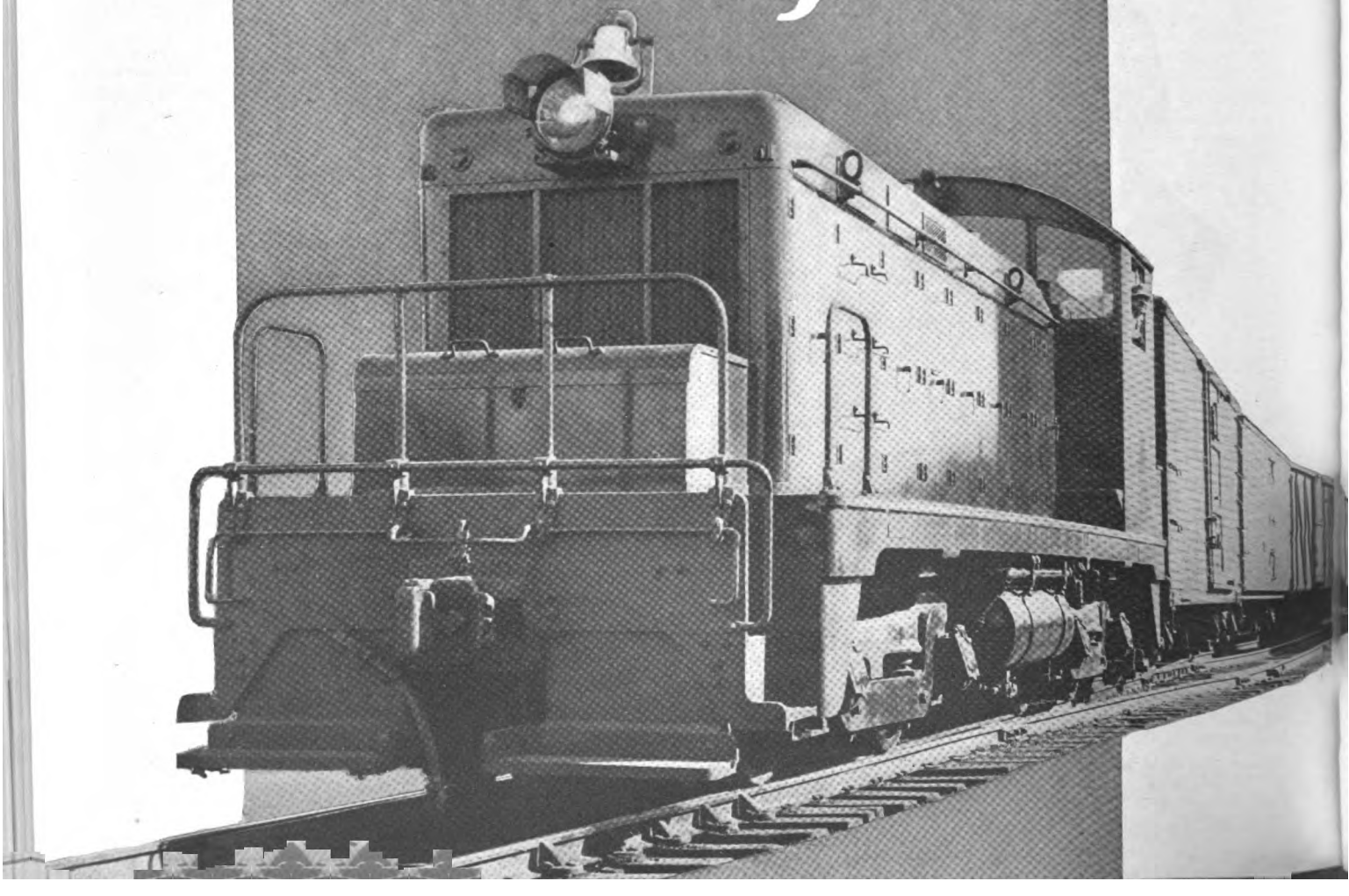
F. J. CARTY, mechanical engineer of the Boston & Albany, with headquarters at Boston, Mass., has been appointed master mechanic with the same headquarters.

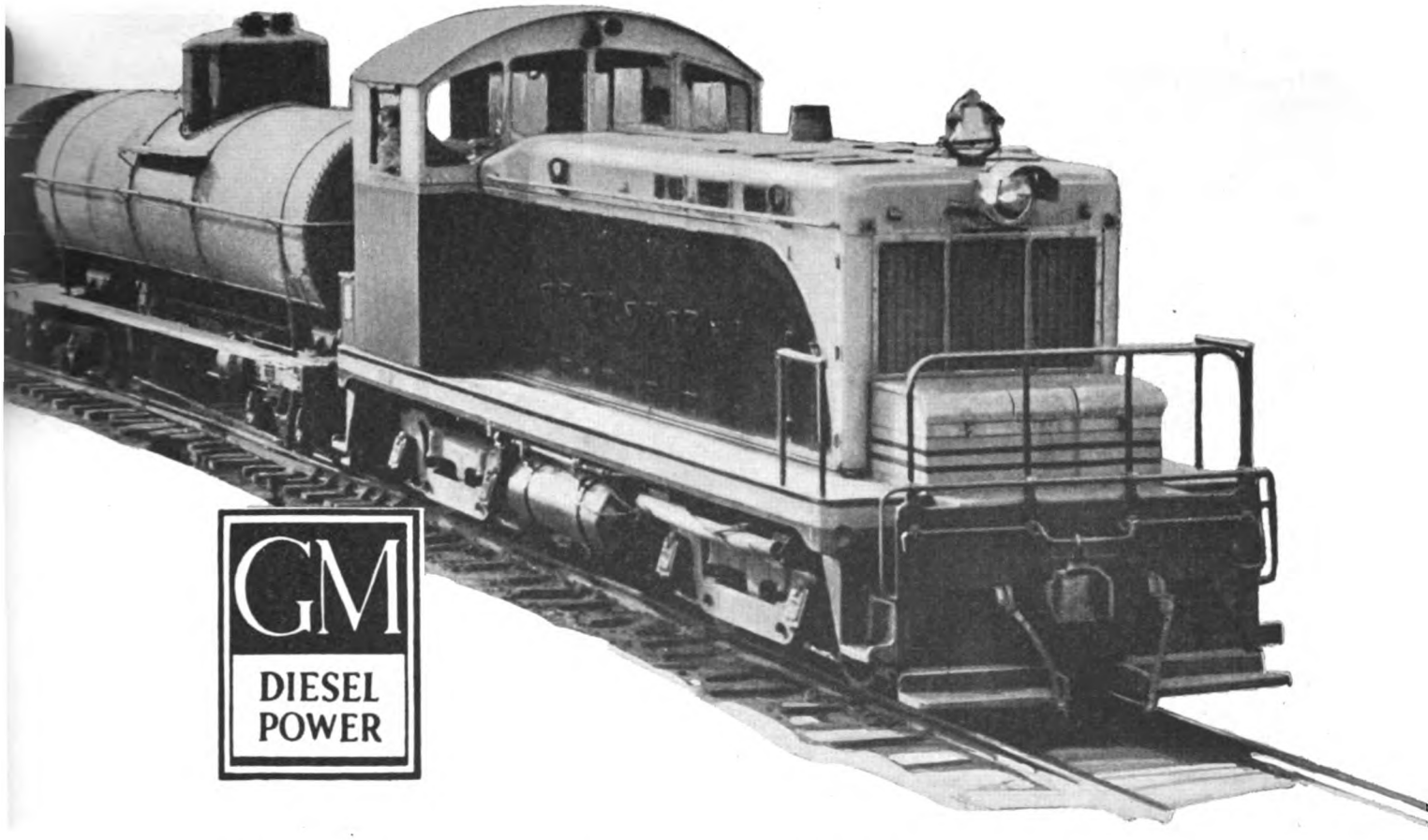
CHAS. J. DIETRICH, who has been appointed master mechanic of the Galesburg-Ottumwa division of the Chicago, Burlington & Quincy at Galesburg, Ill., as announced in the October issue, was born on March 16, 1892, at Lincoln, Nebr. He received a high-school education and from 1910 until 1914 was a machinist apprentice in the employ of the C. B. & Q., first at Lincoln, and a year later at Havelock, Nebr. From 1914 until 1922 he was engaged in outside business. Returning to the Burlington he became lead machinist at Lincoln on October 25, 1922; enginehouse foreman at Casper, Wyo., on November 27, 1925; general foreman at Wymore, Nebr., on June 1, 1926; general foreman at Alliance, Nebr., on September 1, 1928; day enginehouse foreman at Alliance on November 5, 1931; general foreman at Lincoln on August 1, 1935; master mechanic at McCook, Nebr., on May 16,

(*Continued on second left-hand page*)



Over One Million Hours of $ubstantial $avings





NO other type of motive power has so convincingly demonstrated its capability of effecting substantial savings in operating costs as EMC Diesel Switchers.

With over ONE MILLION hours of service to date, EMC 600 Hp. and 900 Hp. Diesel switchers are operating with an average hourly fuel consumption of 4.8 and 7.2 gallons per hour respectively, which is equivalent to an 80 per cent reduction in fuel expense.

But EMC Diesel economies go far beyond fuel savings. Maintenance costs have been cut in half — enginehouse expenses reduced to a third and water costs to practically nothing. And for SERVICEABILITY — the 600 Hp. and 900 Hp. EMC Diesels are averaging 94 per cent availability with some records as high as 98 per cent.



ELECTRO-MOTIVE CORPORATION

SUBSIDIARY OF GENERAL MOTORS LA GRANGE, ILLINOIS, U. S. A.

1936; master mechanic at Alliance on March 1, 1937, and master mechanic at Galesburg on September 16, 1938.

Car Department

B. H. BARRETT, general car inspector on the Chicago, Burlington & Quincy, with headquarters at Lincoln, Neb., has been promoted to superintendent of shops at Havelock, Neb., succeeding J. D. Rezner.

J. D. REZNER, superintendent of shops of the Chicago, Burlington & Quincy at Havelock, Neb., has been appointed general car foreman, with headquarters at Chicago.

H. H. HARVEY, general car foreman of the Chicago, Burlington & Quincy at Chicago, retired on November 1.

WILLIAM P. SHOTWELL has been appointed supervisor of air-conditioning and lighting of the Erie with headquarters at Susquehanna, Pa. Mr. Shotwell, who will report to the superintendent of the car department at Cleveland, Ohio, will be responsible for the proper functioning and maintenance of air-conditioning equipment and car lighting and also for the overhauling of this equipment while cars are going through the shop.

Shop and Enginehouse

I. N. MOSELEY, who has been appointed master boilermaker of the Norfolk & Western system, with headquarters at Roanoke, Va., as noted in the October issue, was born at Vinton, Va., on November 13, 1894, and entered the service of the Norfolk & Western as a draftsman in the mechanical engineer's office. He was promoted to the position of mechanical inspector on May 1, 1924, and on July 2, 1925, became general foreman of the foundry department at Roanoke shops. Mr. Moseley succeeds John A. Doanberger, retired.



I. N. Moseley

JOHN A. DOANBERGER, who has retired as master boilermaker of the Norfolk & Western as noted in the October issue, was born in Hagerstown, Md., on August 6, 1867. He began his career as a boilermaker apprentice on April 1, 1883, in the employ of the Hagerstown Steam Engine and Machine Company. On September 24, 1886, he went to Roanoke as a boilermaker at the machine works of the Norfolk & Western. He became assistant foreman of the boiler shop on April 1, 1889, and foreman on July 1, 1893. He resigned on September 21, 1897, to become superintendent of the boiler department of the American Locomotive Company at Richmond, Va. After three years' service with the American Locomotive Company and the Lake Shore & Michigan Southern at Cleveland, Ohio, Mr. Doanberger returned to the Norfolk & Western as boiler shop foreman, and on December 16, 1907, was appointed master boilermaker for the system.



J. A. Doanberger

Obituary

J. BERTRAM YOUNG, engineer of tests of the Reading since 1920, died on July 29.

C. E. BURCHFIELD, superintendent of the Knoxville division of the Southern, with headquarters at Knoxville, Tenn., died on October 5.

OSCAR G. MCPHAIL, fuel supervisor on the Louisville & Nashville, with headquarters at Louisville, Ky., died on September 25.

WERNER C. GROENING, retired chief air-brake inspector of the Chesapeake & Ohio at Grand Rapids, Mich., died on August 18 at the age of 76. Mr. Groening had served as a machinist, erecting foreman, general foreman, superintendent of shops, inspector of equipment and road foreman of engines before being promoted to the position of chief air-brake inspector in 1918.

G. E. COUTANT, chief draftsman of the Wabash passed away October 13. Mr. Coutant entered railroad service as a car repairer for the Wabash, St. Louis & Pacific, at Butler, Ind., in 1888. Later Mr. Coutant was employed by the Louisville & Nashville at Louisville, and in 1892 entered the service of the Wabash at Springfield, Ill., as a draftsman, where he remained until 1911, when he went with the Ann Arbor as master mechanic. In 1914 Mr. Coutant re-entered the employ of the Wabash at Springfield, Ill., as general inspector, was transferred to Decatur, Ill., in 1915, and made assistant to superintendent motive power in 1917. In 1932, in addition to his other duties, he assumed charge of the drafting room, with the title of chief draftsman.

JOHN WILLIAM SASSER, consulting superintendent motive power of the Virginian, with headquarters at Norfolk, Va., died at his home near Raleigh, N. C., on October 16, at the age of 61. Mr. Sasser had been superintendent motive power from January 1, 1921, until June 1, 1938, when, due to ill health, he was appointed consulting superintendent motive power. A detailed sketch of Mr. Sasser's railroad career was published in the July, 1938 issue of the *Railway Mechanical Engineer*.

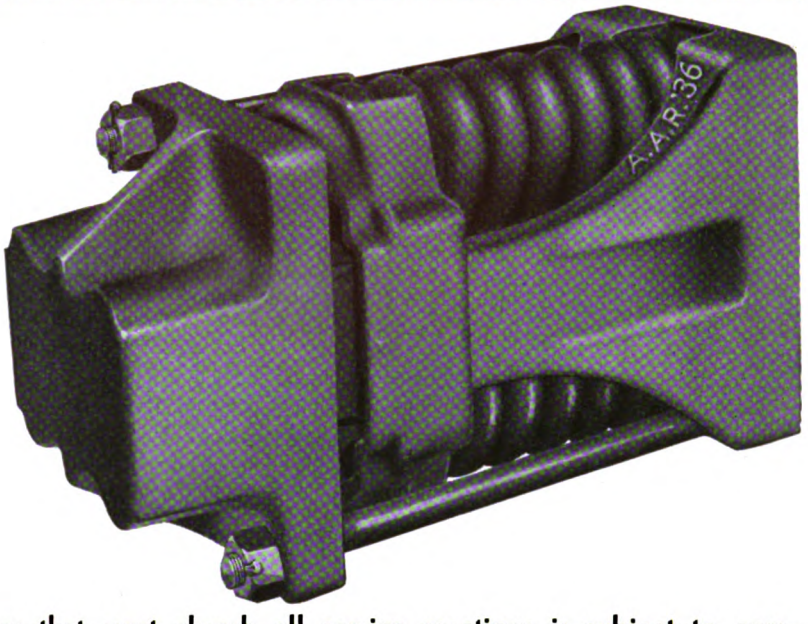
C. A. ZWEIBEL, general foreman of the car department at the South Louisville shops of the Louisville and Nashville, died October 14. After serving in various capacities with the Atlantic Coast Lines and the Central of New Jersey, Mr. Zweibel went to work for the Louisville & Nashville as general foreman of the car department at Boyles, Ala., on September 15, 1919, being transferred in a similar capacity to the South Louisville shops on October 1, 1927.

GEORGE W. SMITH, former superintendent of motive power of the Chicago & Eastern Illinois, and retired superintendent of machinery of the Missouri Pacific, died on October 14 at his home in Evanston, Ill. Mr. Smith was born at Rochester, N. Y., on February 29, 1856, and entered railway service in 1870 as an engine-wiper on the Chicago and Iowa (later a part of the Chicago, Burlington and Quincy), at Aurora, Ill. He later became a fireman on the Michigan Central at Joliet, Ill., and a machinist apprentice for the same road at Jackson, Mich. In 1877, he returned to the Chicago and Iowa as a machinist at Aurora, and in 1878, became associated with the Atchison, Topeka and Santa Fe as a machinist at Topeka, Kan. He subsequently served the Santa Fe as enginehouse foreman at Argentine, Kan., and master mechanic at Nickerson, Kan.; Topeka, Kan., and Albuquerque, N. M. Mr. Smith left the Santa Fe in the summer of 1902 to become master mechanic of the Illinois Central, with headquarters at Waterloo, Iowa. The following spring he was appointed assistant superintendent of machinery with headquarters at Chicago. In the spring of 1904, he left the Illinois Central to go with the Chicago and Eastern Illinois as superintendent of motive power, with headquarters at Danville, Ill. A year later he became superintendent of machinery of the Missouri Pacific, with headquarters at St. Louis, Mo., from which position he retired in June, 1911.

JOHN HENNESSEY, retired master car builder of the Chicago, Milwaukee, St. Paul & Pacific, died at Milwaukee, Wis., on September 27. Mr. Hennessey was born in Waukesha County, Wis., in 1847, and entered railway service in July, 1871, in the Milwaukee shops at Prairie du Chien, Wis. He was later transferred to the shops at Milwaukee and Chicago. In 1879 he was

(*Continued on next left-hand page*)

NATIONAL A.A.R. APPROVED DRAFT GEARS



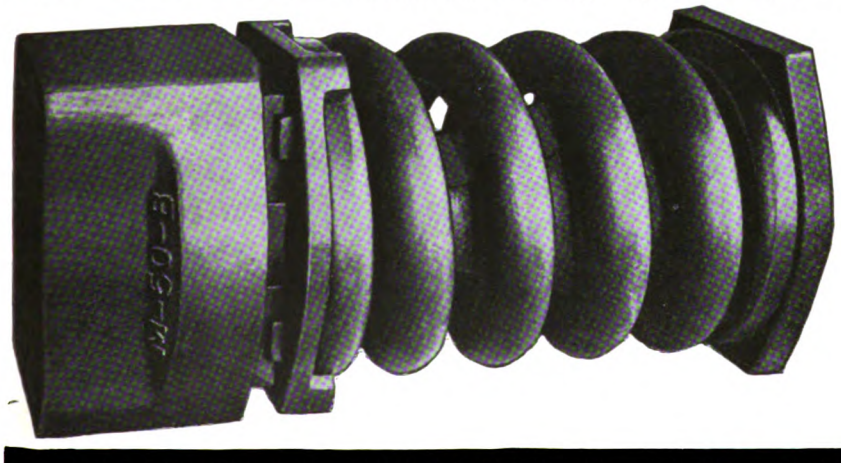
NATIONAL M-17-A DRAFT GEAR
22 3/8" long
A.A.R. Approved

NATIONAL Draft Gears are necessarily sturdy in design to satisfactorily meet present day service requirements at lower cost.

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promoted to foreman at the Milwaukee shops, and in 1880 he was appointed inspector of new car construction at the various contract shops where the Milwaukee was having passenger and freight cars built. In 1887 he was advanced to general foreman of the West Milwaukee



John Hennessey

car department shops, and in 1888 was promoted to master car builder, with headquarters at Milwaukee, the position he held until his retirement in February, 1918. Mr. Hennessey initiated many improvements in car construction, some of which he patented, notably the steel center sills in conjunction with continuous steel body bolster, door fixtures, rocker frictionless side bearing, and a friction draft gear, which was one of the first gears of the friction type. He was especially active in the Mechanical division of the Association of American Railroads and its predecessor, the Master Car Builders' Association, of which he was president in 1902. He served on various important committees notably the Executive and Arbitration committees, having a record of 35 years' continuous membership on the latter, including 17 years as chairman.

FRED P. PFAHLER, who resigned in 1930 as assistant to chief of motive power and equipment of the Seaboard Air Line at Savannah to accept a position as service agent with the Interstate Commerce Commission at Washington, D. C., died on October 14. Mr. Pfahler was born at Sunbury, Pa., on June 21, 1875, and entered the service of the Pennsylvania as yard clerk on the Sunbury division in November, 1889, going with the Baltimore & Ohio in March, 1899, as fireman on the Connellsville division and machinist at Pittsburgh, Pa. In October, 1904 Mr. Pfahler became enginehouse foreman of the Erie at Buffalo, N. Y., and in January, 1905, returned to the B. & O. as machine shop foreman at Willard, Ohio. From May to September, 1905, he was general foreman on the Seaboard Air Line at Hamlet, N. C.; then serving until April, 1906, as draftsman on the Baltimore & Ohio at Baltimore, Md. From April, 1906, to October, 1911, he was mechanical engineer of the Wheeling & Lake Erie at Norwalk, Ohio, returning to the B. & O. in March, 1916, and serving successively as general mechanical inspector at Baltimore, master mechanic of the Pittsburgh and Cumberland divisions, supervisor locomotive maintenance at Baltimore and district master mechanic at Pittsburgh, Pa. He was assistant to chief of motive power and equipment of the Seaboard Air Line from October 1, 1925, to April, 1930.

T. F. BARTON, superintendent motive power of the Chesapeake & Ohio, with headquarters at Richmond, Va., died on October 14. Mr. Barton was born in London, England, on March 21, 1867, and began his railroad career in 1887 with the Grand Trunk. He remained in the employ of that road for six years, serving successively as machinist apprentice, locomotive fireman and journeyman. During the 10 years he served with the Illinois



T. F. Barton

Central he held the positions of machinist, gang foreman, enginehouse foreman, general foreman, master mechanic and superintendent of shops. Prior to his connection with the Chesapeake & Ohio he was in the employ of the Delaware, Lackawanna & Western for a period of 15 years, serving in the capacity of master mechanic at Kingsland, N. J., when he accepted the position of master mechanic of the C. & O. He was appointed general master mechanic of the Western General division at Huntington, W. Va., on February 1, 1924, which position he held until May, 1930, when he was promoted to superintendent motive power at Richmond.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

SPRAY EQUIPMENT.—Eclipse Air Brush Co., Inc., Newark, N. J. 32-page booklet, illustrated. Points out savings and advantages of Eclipse spray equipment under practical working conditions. Test data.

◆

TANTALUM CARBIDE TOOLS AND BLANKS. Vascoloy-Ramet Corporation, North Chicago, Ill. Twelve-page catalog and price list of Vascoloy-Ramet standard tantalum carbide tools and blanks.

◆

CHECK VALVES.—Crane Co., 836 South Michigan avenue, Chicago. 8-page booklet, "Checking up on Check Valves." Describes two basic types of check valves and their various applications.

◆

FOOT INJURIES. — Lehigh Safety Shoe Co., Allentown, Pa. "A Handbook of Facts for the Safety Engineer." Devoted to a showing of Lehigh safety shoes and informative material on general industrial safety, including several factory-tested suggestions on how industrial injury frequency rates can be reduced.

FORGING PRESSES.—The Ajax Manufacturing Company, Euclid Branch P. O., Cleveland, Ohio. Bulletin No. 75; 16 pages. Describes and illustrates Ajax solid frame forging presses, with air-operated clutch, for accurate hot forging and precision hot and cold coining. Press sizes 500 to 2,000 tons.

◆

U. S. S. HIGH-TENSILE STEELS.—Carnegie-Illinois Steel Corporation, 434 Fifth avenue, Pittsburgh, Pa. Eight-page illustrated booklet. Technical and general information concerning applications, advantages and fabrication of U. S. S. high-tensile steels—Cor-Ten, Man-Ten and Sil-Ten. Charts of chemical compositions, physical properties and miscellaneous information.

VALVES, BOILER MOUNTINGS, ETC.—The Lunkenheimer Co., Cincinnati, Ohio. 44-page List Price Schedule covering entire line of valves, boiler mountings, and lubricating devices. Listed numerically by figure number.

◆

WELDING ALUMINUM.—Aluminum Company of America, Pittsburgh, Pa. Revised 48-page, illustrated booklet on welding aluminum and its alloys. Sections on fusion welding, welded aluminum vessels, torch welding heat-treated aluminum alloys, welding castings, arc welding, and resistance welding.

◆

REPLICAS OF LOCOMOTIVES. — Simmons-Boardman Publishing Corporation, Book Service Department, 30 Church street, New York. A four-page bulletin, "Exact Replicas of Great Locomotives," illustrating heavy silver-plated replicas, with an oxidized finish, for use as paperweights, (mounted on a padded metal base shaped like a railway roadbed) or as pen and pencil trays (mounted on onyx). Prices given.

RAILWAY MECHANICAL ENGINEER

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal and Railway Master Mechanic. Name Registered, U. S. Patent Office.



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MATERIAL

is only part of the cost

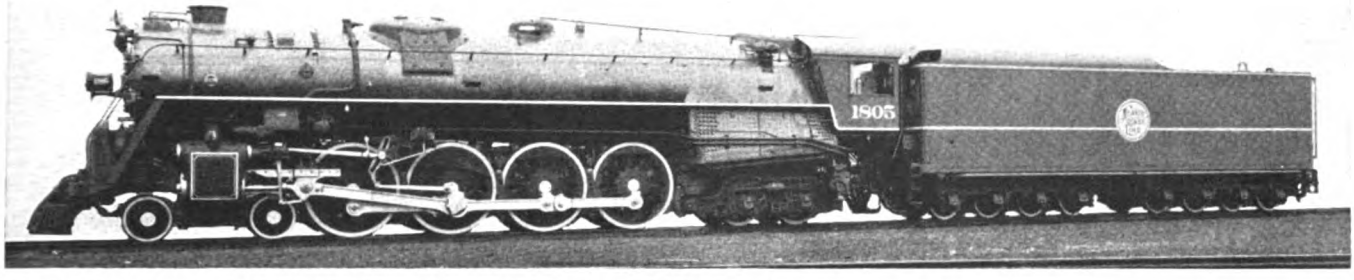
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Atlantic Coast Line locomotive for fast, heavy passenger-train service, built by Baldwin

A. C. L. 4-8-4 Locomotives

Largest locomotives in the South purchased from Baldwin for service on Florida trains —Designed to handle 21 standard cars

DURING the late summer the Atlantic Coast Line took delivery on 12 heavy 4-8-4 type passenger locomotives, built at the Baldwin Locomotive Works, which are now being used on the fast, heavy passenger trains between Richmond, Va., and Jacksonville, Fla., a distance of 681 miles. This motive power has exceptional capacity, with a starting tractive force of 63,900 lb. and a potential boiler horsepower of 4,170. The railroad has designated this group as Class R-1 and has assigned the road numbers 1800 to 1811.

At the present time these locomotives are working on the A. C. L.'s "Tamiami" and "Havana Special" trains, north and southbound. The former are night runs between Richmond and Jacksonville and make the run of 681 miles in 13¼ hours, including ten stops in each direction, while the latter are mainly daylight trains which make their respective runs in 14 hrs. 15 min. southbound and 14 hrs. 5 min. northbound. These trains vary in consist with the traffic, but the locomotives will handle 20 and 21 standard cars at schedule speeds. The maximum grades encountered are 0.6 per cent and the curvature is 3 deg. maximum. Some of these locomotives are making over 18,000 miles a month and the group are now beginning to pass through the shop for light repairs after having run total mileages of over 75,000.

The Boiler

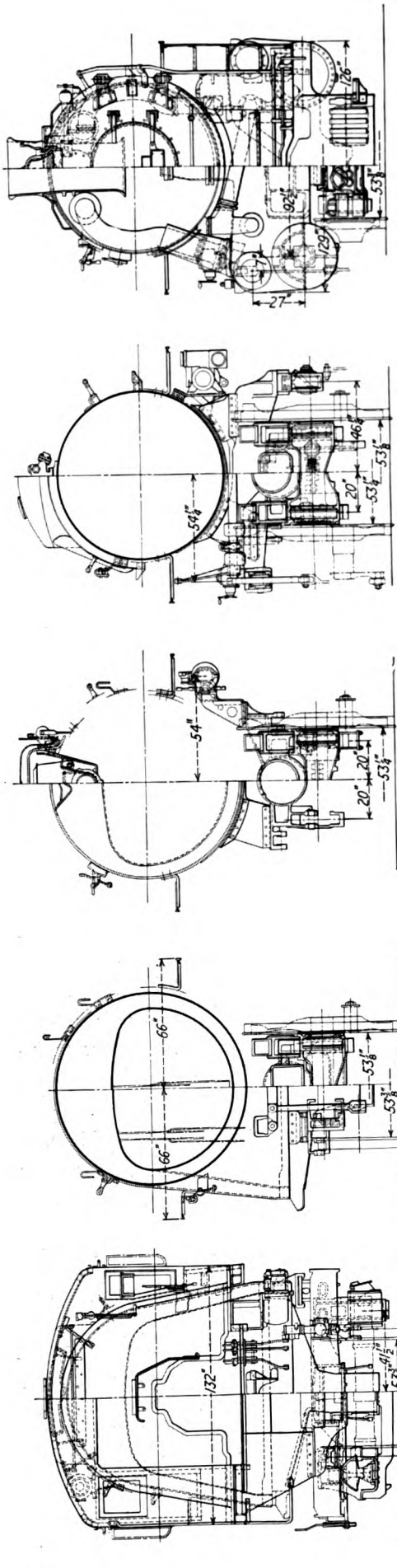
The boilers are of the conical type, built in three courses. The first and third courses are 84½ in. and 96 5/16 in. inside diameter, respectively. The barrel plates in the three courses are nickel steel 27/32 in., 15/16 in. and 31/32 in. thick. The combustion chamber is 72 in. long and the plate thickness is ⅜ in. There are 58 5½-in. flues and 198 2¼-in. tubes, 21 ft. over the tube sheets. The tube sheets are both ⅝-in. thick. The firebox plates are acid carbon steel. The firebox width is 102 in., with a length of 138 in. and a grate area of 97.75 sq. ft. The roof sheet is 13/16 in. thick and the sides, inside throat and back head are ½ in. thick. The crown and sides are in one piece, ⅜ in. thick. The outside throat sheet is 27/32 in. thick and the inside back furnace sheet is ⅜ in. The water spaces are 5 in. at the back and sides and 6 in. at the front. Three Thermic syphons are located in the firebox and one on the center line of the boiler in the combustion chamber. No arch tubes are used, the Security brick arch being supported on the syphons.

Welding and Staying

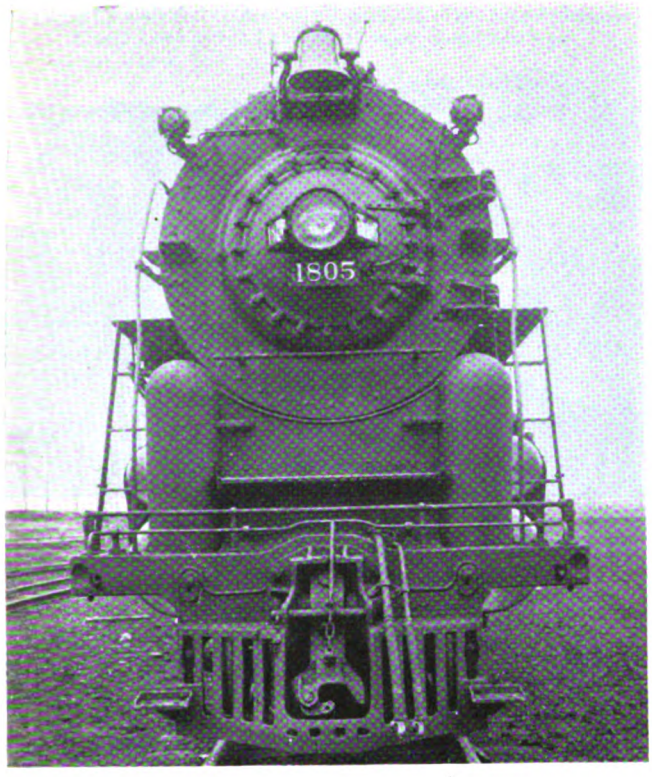
All of the seams inside the firebox are welded, including the seam in the combustion chamber. The sheets, inside and outside, are seal-welded to the mud ring for a distance of 12 in. each way from the corners. The syphons are welded into the firebox plates. The barrel course seams are welded for distances of from 11 in. to 16½ in. from the ends. The firedoor hole is welded.

The dome is a one-piece open-hearth-steel forging 36 in. in diameter. The fireboxes and combustion chambers are stayed with Flannery bolts. Flexible bolts with U-type sleeves are used in the back head, combustion chamber and throat sheet. Expansion stays with WR sleeves and caps are used across the front four rows of the combustion chamber and along the crown-sheet bend. The crown stays in the 13 central rows are the taper-end type.

The firedoor opening is 25 in. by 25⅝ in. and a Franklin No. 8 Butterfly door is used. The grates are the railroad company's standard Rosebud design and bituminous coal is fed by a Standard HT stoker. Water is fed to the boiler by one Nathan 10,000-gal. capacity injector and by a Worthington Type 5½ SA feedwater heater. A 58-element Elesco Type A superheater, American multiple throttle and Tangential steam dryer form part of



Elevation and cross-sections of the Atlantic Coast Line 4-8-4 type locomotives



the steam supply and control equipment. The feedwater heater is located ahead of the stack and both hot- and cold-water pumps are under the runboards on the left side.

Other boiler equipment consists of Okadee smokebox hinges, blow-off cocks and mufflers, and Consolidated 3½-in. safety valves.

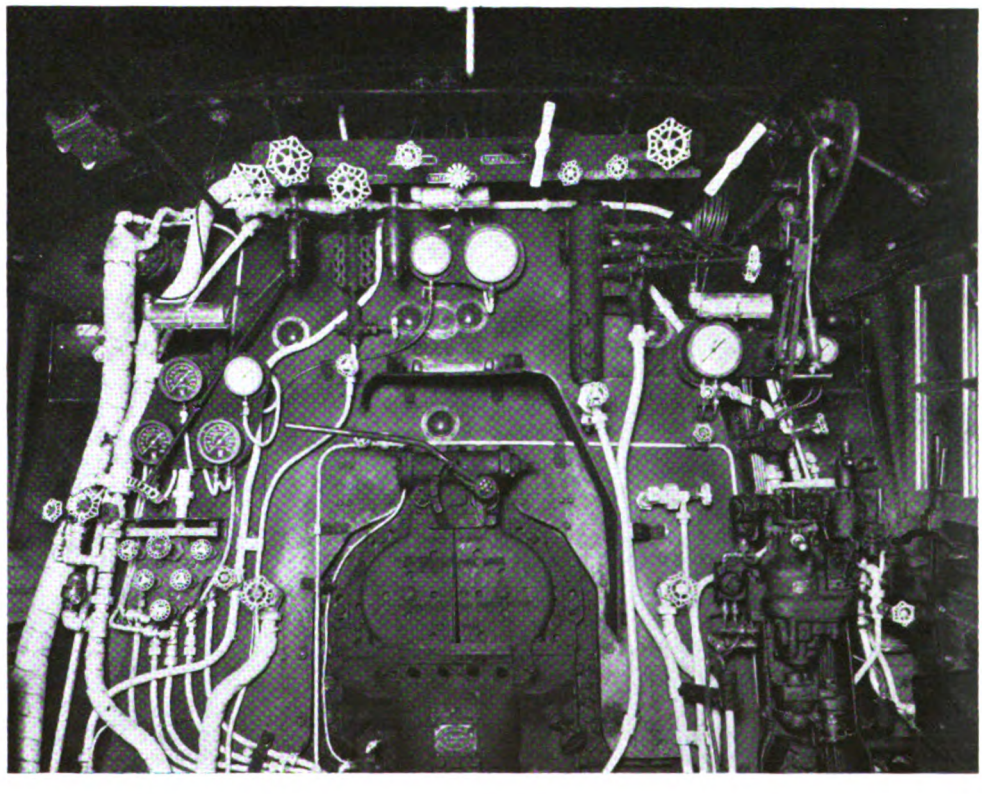
Machinery Details

A one-piece bed, supplied by the General Steel Castings Corporation, forms the foundation of these locomotives. Cast integral with the bed are the cylinders and back heads, main reservoirs, brackets for the air compressors, guide and valve-gear supports, brake hangers, firebox expansion pads and brackets for trailer-truck rockers. The steel pilot casting is designed to take a National Type E. drop coupler.

The front truck is of the constant-resistance type, with

General Dimensions, Weights and Proportions of the Atlantic Coast Line 4-8-4 Locomotives

Railroad	A. C. L.
Builder	Baldwin
Type of locomotive	4-8-4
Road class	R 1
Road numbers	1800—1811
Date built	April, 1938
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	16— 1
Height to center of boiler, ft. and in.	10— 8½
Width overall, in.	132
Cylinder centers, in.	92½
Weights in working order, lb.:	
On drivers	263,127
On front truck	89,343
On trailing truck	107,800
Total engine	460,270
Tender	435,500
Wheel bases, ft. and in.:	
Driving	20— 9
Rigid	13—10
Engine, total	47— 9
Engine and tender, total	97—11
Wheels, diameter outside tires, in.:	
Driving	80
Front truck	36
Trailing truck	43
Engine:	
Cylinders, number, diameter and stroke, in.	2—27x30
Valve gear, type	Walschaert
Valves, piston type, size, in.	12
Maximum travel, in.	7½
Steam lap, in.	1⅜
Exhaust clearance, in.	¼
Lead, in.	1/4
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	275
Diameter, first ring, inside, in.	86 3/16
Diameter, largest, outside, in.	98¼
Firebox length, in.	138
Firebox, width, in.	102
Height mud ring to crown sheet, back, in.	74
Height mud ring to crown sheet, front, in.	92
Combustion chamber length, in.	72
Thermic syphons, number	Four
Tubes, number and diameter, in.	198—2¼
Flues, number and diameter, in.	58—5½
Length over tube sheets, ft. and in.	21—0
Fuel	Soft coal



The back head of the A.C.L. 4-8-4 type locomotives



These locomotives are equipped with the first eight-wheel tender trucks

Stoker	Standard HT
Grate area, sq. ft.	97.75
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	399
Thermic syphons	169
Firebox, total	568
Tubes and flues	4,181
Evaporative, total	4,749
Superheating	1,497
Comb. evap. and superheat	6,246
Tender:	
Type	Rectangular
Water capacity, gallons	24,000
Fuel capacity, tons	27
Trucks	Eight-wheel
Journals, diameter and length, in.	6½x12
Rated tractive force, engine 85 per cent, lb.	63,900
Weight proportions:	
Weight on drivers ÷ weight, engine, per cent	57.2
Weight on drivers ÷ tractive force	4.12
Weight of engine ÷ evaporative heating surface	96.9
Weight of engine ÷ comb. heat. surface	73.7
Boiler proportions:	
Firebox heat. surface, per cent comb. heating surface	9.09
Tube-flue heat. surface, per cent comb. heat. surface	66.9
Superheat surface, per cent comb. heat. surface	24.0
Firebox heat. surface ÷ grate area	5.81
Tube-flue heat. surface ÷ grate area	42.8
Superheat. surface ÷ grate area	15.3
Comb. heat. surface ÷ grate area	63.9
Evaporative heat. surface ÷ grate area	48.6
Tractive force ÷ grate area	653.6
Tractive force ÷ evaporative heat. surface	13.5
Tractive force ÷ comb. heat. surface	10.2
Tractive force × diam. drivers ÷ comb. heat. surface	818.4

a swing of 6 in. each side of the center line and arranged for the future application of air brakes. The trucks were built by the General Steel Castings Corporation and have 36-in. wheels, 9⅝-in. journals and A. S. F. roller-bearing units. The trailing truck is the Delta four-wheel type with 43-in. wheels front and back, and 9-in. by 14-in. journals with plain bearings. It is arranged for the future application of a booster.

The driving wheels are of the Baldwin disc type mounted on axles running in Timken roller bearings. The main journals are 13¼ in. and the other three are 11½ in. The main wheels are cross balanced. Alco lateral-motion driving boxes are used on the front drivers.

The reciprocating weights on one side of the engine total 2,241 lb., 40 per cent of which are balanced. The dynamic augment at 80 m.p.h. is 10,780 lb.

The cylinders are two in number, 27 in. bore and 30 in. stroke. The piston valves are 12. in diameter and have a maximum travel of 7½ in. The piston heads are rolled steel. Elfur iron cylinder and valve-chamber bushings and packing rings, and King piston and valve-rod packing are part of the cylinder equipment.

The valve gear is Walschaert, operated by a Baldwin Type C power reverse gear. The guides are the multiple-bearing type with underhung cast-steel crossheads, furnished by the Standard Steel Works.

Two Nathan mechanical lubricators, type DV-7, each of 36 pints capacity, placed one on each side of the locomotive, supply oil to the valves and cylinders, the stoker, feedwater heater, main guides, valve stem guides, driving-box pedestals, front and back engine-truck pedestals, back truck floating hub liners, and link trunnions. Alemite lubrication is applied to the valve motion, spring rigging, brake work, connecting rods, throttle rigging and mechanical lubricator rigging.

The air-brake equipment is Westinghouse No. 8 ET with two 8½-in. compressors mounted on the bed in front of the smokebox. The locomotives are equipped with General Railway Signal intermittent, inductive, automanual train control.

Other equipment on the engines consists of Franklin radical buffers between the engine and the tender, Ashcroft steam, back-pressure and air gages, Prime clear vision windows, Sunbeam electric headlight and generator, Hancock steam-heat valves and Leslie pressure regulators. Barco flexible connections are used between the engine and the tender.

The Tenders

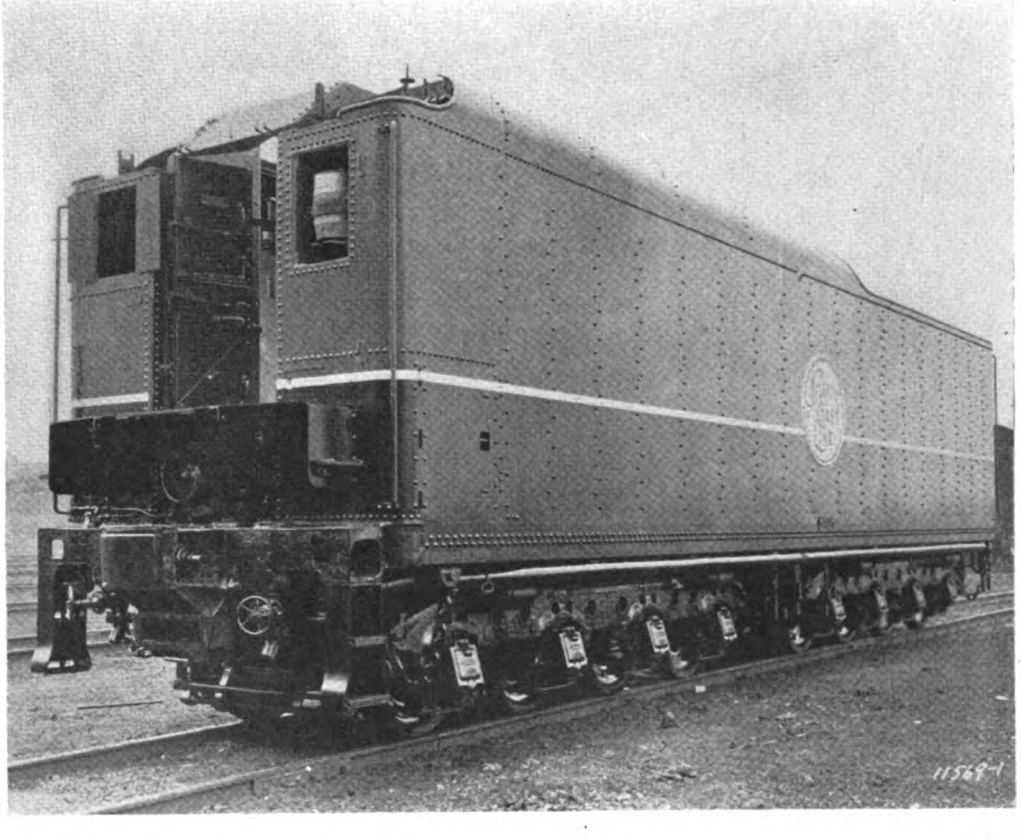
Long passenger train runs necessitated large tenders on these locomotives. They have a water capacity of 24,000 gal. and a fuel capacity of 27 tons of coal. They are the first to be carried on eight-wheel trucks. The tanks are of the rectangular type built of Cor-Ten steel plates. The tender frames and the truck frames are cast steel and were furnished by the General Steel Castings Corporation. The loaded weight of the tender is 435,-500 lb., an average of 27,200 lb. per wheel. The trucks have rigid frames and swing bolsters and are carried on 36-in. rolled-steel wheels, plain bearings and 6½-in. by 12-in. journals.

The tender trucks are equipped with Unit Cylinder clasp brakes with four independent cylinders on each truck. The braking ratio is 100 per cent at 50 lb. cylinder pressure.

The coupler at the rear end of the tender is a National Type E rotary passenger coupler with Miner A5XB draft gear and McConway & Torley yoke. Barco flexible steam-heat connectors are used at the rear of the tender.

Partial List of Materials and Equipment on the Atlantic Coast Line 4-8-4 Type Passenger Locomotives

Bed castings; engine and trailer trucks	General Steel Castings Corp., Eddystone, Pa.
Driving wheels	The Baldwin Locomotive Works, Philadelphia, Pa.
Driving and trailer tires; engine-truck wheel tires	American Locomotive Co., Railway Steel Spring Div., New York
Driving journal bearings	The Timken Roller Bearing Company, Canton, Ohio
Engine-truck bearings	American Steel Foundries, Chicago
Bearings, trailer (front and rear), tender	National Bearing Metals Corp., St. Louis Mo.
Springs	Standard Steel Works Co., Burnham, Pa.
Lateral motion device	American Locomotive Co., New York
Radial buffer, E-2	Franklin Railway Supply Co., Inc., New York
Mechanical lubricators	Nathan Manufacturing Co., New York
Grease lubrication	Alemite Div. Stewart-Warner Corp., Chicago
Air-brake equipment	Westinghouse Air Brake Co., Wilmerding, Pa.
Pump packing	U. S. Metallic Packing Co., Philadelphia, Pa.
Air gages	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Foundation brake equipment	American Brake Co., St. Louis, Mo.
Train control	General Railway Signal Co., Rochester N. Y.
Piston rings and piston-valve rings; cylinder bushings and valve-chamber bushings of Elfur iron	Cramp Brass & Iron Foundries Co., Philadelphia, Pa.
Piston-rod and valve-stem packing	U. S. Metallic Packing Co., Philadelphia, Pa.
Rod bushings	National Bearing Metals Corp., St. Louis, Mo.
Power reverse gear	The Baldwin Locomotive Works, Philadelphia, Pa.
Crossheads	Standard Steel Works Co., Burnham, Pa.
Coupler, engine	National Malleable and Steel Castings Co., Cleveland, Ohio
Pedestal shoes	National Bearing Metals Corp., St. Louis, Mo.
Staybolt iron:	
Solid	Ulster Iron Works, Dover, N. J.
Hollow	Joseph T. Ryerson & Son, Inc., Chicago
Staybolts	Flannery Bolt Co., Bridgeville Pa.
Thermic syphons	Locomotive Firebox Co., Chicago
Tubes and flues	(6) Globe Steel Tubes Co., Milwaukee, Wis. (6) Pittsburgh Steel Co., Pittsburgh, Pa.
Superheater	The Superheater Company, New York
Superheater pipes	(6) Globe Steel Tubes Co., Milwaukee, Wis. (6) Pittsburgh Steel Co., Pittsburgh, Pa.
Tangential steam dryer	The Superheater Company, New York
Smokebox netting	The W. S. Tyler Co., Cleveland, Ohio
Smokebox hinges	The Okadee Company, Chicago
Throttle valve	American Throttle Co., New York
Lagging	Johns-Manville Sales Corp., New York
Firebrick	American Arch Co., Inc., New York
Feedwater heater	Worthington Pump and Machinery Corp., Harrison, N. J.
Injectors; injector steam valve; double boiler check valves	Nathan Manufacturing Co., New York
Line check valve for injector	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Fuel sprinkler	Nathan Manufacturing Co., New York
Blow-off cocks and mufflers	The Okadee Company, Chicago
Blower valves	Crane Co., Chicago
Blower fittings	Barco Manufacturing Co., Chicago
Washout plugs	Huron Mfg. Co., Detroit, Mich.
Stoker	Standard Stoker Co., Inc., New York
Fire door	Franklin Railway Supply Co., Inc., New York
Clear vision windows and windshield	The Prime Manufacturing Co., Milwaukee, Wis.
Safety valves; steam gages; back-pressure gages; steam-heat gage; cocks and valves	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Water gage	Handlan, Inc., St. Louis, Mo.
Water column; water-gage fittings	Nathan Manufacturing Co., New York
Steam-heat regulator	The Leslie Co., Lyndhurst, N. J.
Cylinder cocks; exhaust drain cocks	The Prime Manufacturing Co., Milwaukee, Wis.
Sanders	Morris B. Brewster Company, Chicago
Bell ringer	American Locomotive Co., New York
Headlights and generators	Sunbeam Electric Mfg. Co., Evansville, Ind.
Connections between engine and tender for steam, air and stoker lines	Barco Manufacturing Co., Chicago
Tender:	
Tank steel	United States Steel Subsidiaries, New York
Frames and trucks	General Steel Castings Corp., Eddystone, Pa.
Wheels; springs	Standard Steel Works Co., Burnham, Pa.
Boxes, journal	National Malleable and Steel Castings Co., Cleveland, Ohio
Unit Cylinder clasp brakes	American Steel Foundries, Chicago
Brake shoes	American Brake Shoe & Foundry Co., New York
Coupler	National Malleable and Steel Castings Co., Cleveland, Ohio
Draft gear, A5XB	W. H. Miner, Inc., Chicago
Draft yoke	McConway & Torley Co., Pittsburgh, Pa.
Roller side bearings	A. Stucki Co., Pittsburgh, Pa.
Steam-heat connectors rear of tender	Barco Manufacturing Co., Chicago



The tenders, the first to be carried on eight-wheel trucks, have a water capacity of 24,000 gal. and a coal capacity of 27 tons

Many Innovations Included in

Lightweight Welded Cars

All-welded underframes, ends, doors and roofs feature lightweight cars designed and built by the American Car and Foundry Company

ONE 50-ton steel box car and one 40-ton steel refrigerator car having all-welded underframes, ends, doors and roofs were recently built and tested by the American Car and Foundry Company. The box car is of all-welded construction, while on the refrigerator car the final assembly is by riveting. Low alloy, high tensile, corrosion-resistant steel has been used to the fullest extent practicable in both types of cars, the thickness of the plates and shapes being reduced to a minimum consistent with service and durability. In both cars here described the material is Cor-Ten steel. The principal proportions and weights of these cars, as well as manufacturers' products used in their construction, are included in the tables.

New developments incorporated in the all-welded box car include steel ends with extra-long corrugations, steel doors designed for increased rigidity, and a new design of underframe having an all-welded striker integral with drop-forged front draft lugs, also all-welded combined bolster center filler and rear draft lugs. New developments in the refrigerator car, in addition to steel ends and striker as used on the box car, include the ice bunker, ice hatch, removable steel bulkhead, application of insulation, and a new method of using dry ice in combination with water ice. The bolster center filler in the refrigerator car is a special skeleton design of alloy cast steel.

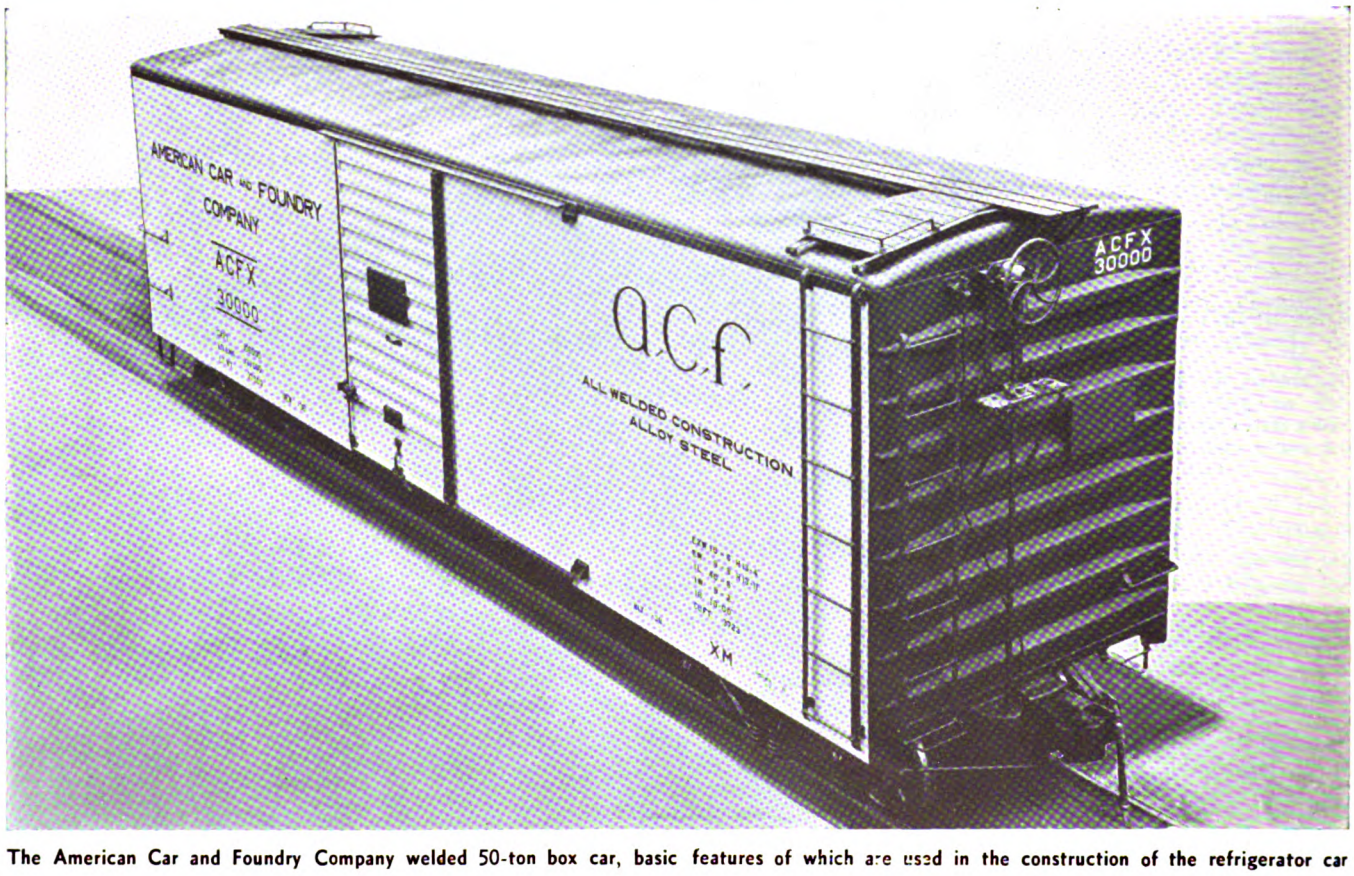
The 50-Ton Box Car

The design of the box car duplicates the 1937 A. A. R. car with respect to inside dimensions, and design strength. However, the new car includes many changes in construction and it has a light weight of 37,500 lb.

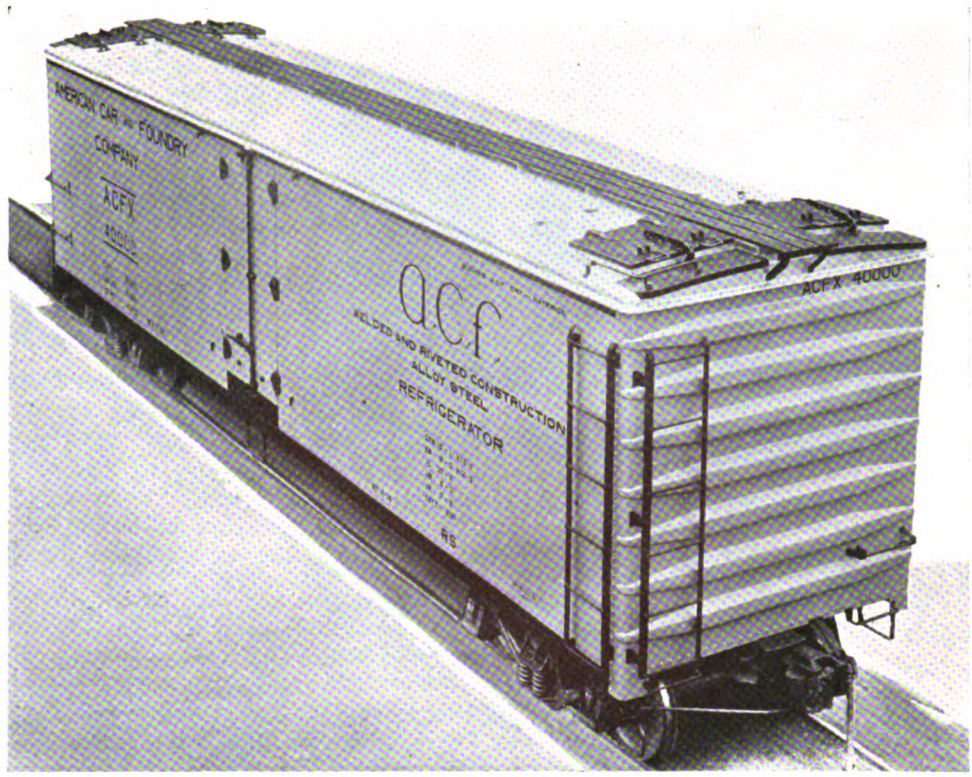
In the design of the box car the structure is divided into a small number of main subassemblies, which are joined into a complete structure by fusion welding; however, the design is such that these subassemblies can be riveted together to form the body if desired. The main subassemblies are as follows: (1) Underframe; (2) sides, including doors; (3) ends; and (4) roof. These four subassemblies are assembled on jigs by both fusion and spot welding, so that when brought together on the assembly track only a small amount of fitting is required.

Each subassembly in turn is made up of several smaller assembled units as follows:

Units of the underframe are (a) the center sills, including strikers, front draft lugs, bolster center fillers, and rear draft lugs, (b) bolsters, (c) crossbearers, and (d) crossties. These units are assembled on welding jigs so as to insure accurate dimensions in the main subassemblies. The center-sill assembly is made up of two A. A. R. Z-section openhearth steel sills (Z-26), with

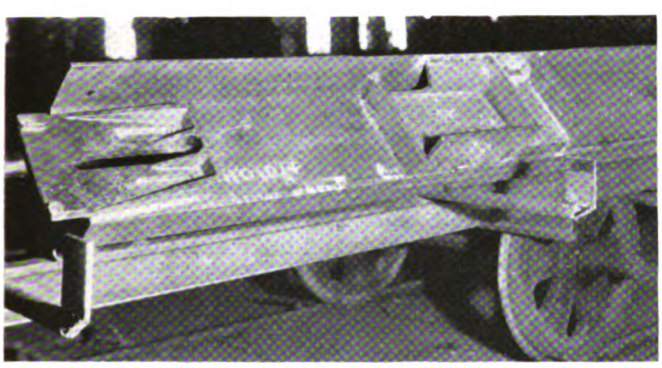


The American Car and Foundry Company welded 50-ton box car, basic features of which are used in the construction of the refrigerator car



Developments in the refrigerator car include the ice bunker, ice hatch, removable steel bulkhead, application of insulation and a new method of using dry ice in combination with water ice

the top flanges welded together from end to end. The cross-sectional area of the sill is 21.3 sq. in. The striker and coupler carrier, including the front draft lugs, are made up of drop forgings and rolled sections welded together and to the center sills. The center-filler and rear-draft-lug unit is built up of low-alloy-steel H-beams and plates all welded together and to the center sills.



The center filler and rear-draft-lug units of the box car are built up of low-alloy steel H-beams and plates all welded together and to the center sills

Each half of the rear draft lug and center-fill construction is first completely welded to its individual sill, and then welded together at the time the two rolled Z-section sill members are welded together.

The body center plate is a steel drop forging with flanges elongated so as to pass under the bottom flanges of the center-sill construction, as well as the body-bolster side member. The center plate is secured to the center sill and bolster construction by a continuous line of welding along the entire length of its flanges. The body center plate thus forms the bottom member of the body bolster construction. The completed center-sill assembly includes separators and a few brake details.

The bolster is made up of two $\frac{5}{16}$-in. U-section pressed plates of low-alloy steel. The bottom of the U-section is the bottom of the bolster. The top member or top cover plate is a 19-in. by $\frac{5}{16}$-in. plate of low-alloy steel welded to the top edges of the U pressings and extending the full width of the car between the side sills. The conventional bottom cover plate is omitted and instead the drop-forged center plate extends outwardly, and is welded to the bottom of the body bolster and bottom flange of the center sills.

Principal Proportions and Weights of the 50-Ton All-Welded Box Car

Length inside, ft. and in.	40-6
Length over striking castings, ft. and in.	41-8½
Truck centers, ft. and in.	30-8½
Width inside, ft. and in.	9-2
Height inside at eaves, ft. and in.	10-0
Height from rails over running board, ft. and in.	14-6¼
Capacity, level full at eaves, cu. ft.	3,723
Light weight, lb.	37,500
Load limit, lb.	131,500
Ratio of pay load to gross load, per cent	77.8
Truck journals, in.	5½ × 10

The bolster pressings are stiffened by braces of low-alloy steel above the side bearing. The side bearing is of high-carbon heat-treated steel riveted to a supporting plate welded to the bottom of the bolster. Pressed-angle stringer supports welded to the bolster complete the assembly.

The crossbearer assembly is also prepared in a jig and consists of $\frac{3}{16}$-in. low-alloy high-tensile steel channels forming a box section. A $\frac{5}{16}$-in. low-alloy high-tensile-steel cover plate is welded to the bottom member of the crossbearers and the center-sill flanges when applied to the sill assembly. Gusset plates of $\frac{5}{16}$-in. low-alloy high-tensile steel connect the crossbearer top member to the center sills.

The crossties are $\frac{1}{8}$-in. low-alloy high-tensile pressed-channel sections forming a support for the floor stringers.

All of these assemblies are provided with brake details which can be conveniently welded in place before the units are applied to the main subassemblies.

The underframe subassembly is completed by assem-

bling the above described units the floor stringers, which are 3-in. 5.1-lb. Z-bars, and end-sill angles all of low-alloy high-tensile steel. The air-brake details are also applied conveniently to the underframe subassembly.

Side Construction Subassembly

The sides are made up of 16-gage low-alloy high-tensile single-pickled sheets spot welded to the framing members, which consist of ⅛-in. pressed Z-section posts, 5/32-in. pressed Z-section corner posts, 3/16-in. pressed angle side sills, 3-in. by 2-in. by 3/16-in. rolled angle side plates, all of low-alloy high-tensile steel. The posts are fusion and spot welded to the side sill and side plates. The transom posts are reinforced by gusset connections to the side sill. The door posts are pressed shapes including spark strips. All of these members are assembled and the side construction completely welded in a jig. The doors are made up of 3/16-in. openhearth-steel pressed stiles and bottom rail, and a 1¾-in. by 1¼-in. by 3/16-in. rolled angle top rail to which is welded a 1/16-in. corrugated low-alloy high-tensile-steel plate made in two pieces spot welded together.

Creco door fixtures are used, including the ball-type support and standard locking device.

Ends

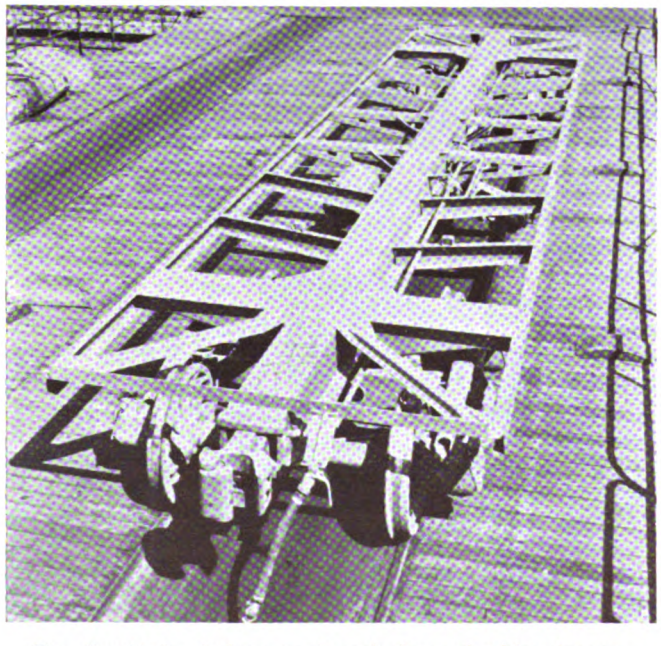
The car ends are made of low-alloy high-tensile-steel sheets provided with special extra-long corrugations, which extend to the end flanges, thereby stiffening them. These ends are built in sections and the sections joined together by fusion welding, the lower half being 5/32 in. and the upper half ⅛ in. The flanges of the car ends are connected to the main body of the end on a curve of approximately 3 in. radius. The corrugations are tapered down and run clear around this curved corner; therefore, stiffening ribs or corrugations extend out into the plane of the anchorage to the side frame. The combination of the round corner with the corrugations extending substantially around this corner gives a pleasing appearance to the corner of the car.

Roof

The roof is the turtle-back type assembled as a unit, having a side-plate angle of 5-in. by 3-in. by 3/16-in. low-alloy high-tensile-steel, with the 5-in. vertical leg formed to a large radius. The roof sheets are of 18-gage low-alloy high-tensile steel, extending from side to side and having a lap joint on every carline. The sheets are spot welded to the side-plate angle, carlines, purlines, and end plates.

The carlines for this roof are of 3/32-in. low-alloy high-tensile steel spaced on 3 ft. 5 in. centers. A Z-shaped purline 2 in. deep and made of 16-gage low-alloy high-tensile steel is applied between the carlines, one on each side of the longitudinal center line of the car.

The roof after being completely assembled is placed on the car body and fusion welded to the car sides and ends, but as stated before, the roof may be attached to car sides and ends by rivets if desired.



The all-welded underframe used on the box and refrigerator cars

Other Details of the Box Car

The doors of this car are bottom hung and are effectively sealed. The spark strips are integral with the door stiles, the top and bottom rails of the door forming the seals. These strips are so designed that increased pressure in closing the door means tighter contact of the surfaces, since the strips are wedge-shaped.

The stiles of the door approach a box section in design and are of 3/16-in. steel. The bottom rail is a special pressed section of 3/16-in. steel whose vertical and horizontal dimensions are 8¼ in. and 2¾ in., respectively. The top rail is a rolled section of 3/16-in. steel. The framework of this door has the strength where it is required, that is, in the two stiles and the bottom rail. However, the door panel has special horizontal corrugations 1⅜-in. in depth extending through the height of the door. This panel is made in two pieces and the assembly is all welded.

The running boards are completely assembled to low-alloy high-tensile-steel saddles before being placed on the car, after which the saddles are fusion welded to roof sheets over each carline and the end supports welded to the end plate.

The end plate is a separate unit made of ⅛-in. low-alloy high-tensile steel formed in one piece, with a large radius formed at the roof line. These end plates are butt-welded to the steel end.

The end sill is made of an integral part of the end construction and consists of a 3½-in. by 3½-in. by 5/16-in. angle of low-alloy high-tensile steel, fusion welded to the steel end.

There are two 3-in. 5.1-lb. Z-bar floor stringer per car, extending from bolster to bolster, fusion welded to underframe cross members and to brackets welded to the bolster web.

The floor support at the side sill is a one-piece 3-in. by 2-in. by 3/16-in. low-alloy high-tensile-steel angle, running the full length of the side sill. It is punched for ½-in. floor bolts. The 2-in. leg is sheared to 1¼-in. and then the angle is spot welded to the side sill.

The car is lined with 25/32-in. by 3¼-in. tongue-and-groove fir, applied horizontally at the sides and vertically at the ends. Side lining is nailed to 2-in. by 2⅞-in. furrings bolted to the side posts, and the end lining is nailed to 3-in. by 3-in. furrings applied in the corrugations of steel ends. These furrings are held in place by ½-in. bolts attached to clips, fusion welded to the steel end.

The ceiling is of ¼-in. plywood applied crosswise of car in one piece from side to side, spliced at each carline. The joint between plywood sections is covered by 18-gage low-alloy high-tensile-steel strips which are attached to the carlines by self-tapping screws.

The floor is of 1¾-in. tongue-and-groove fir laid transversely and secured to floor stringers and floor support on the side sill by ½-in. watertight bolts.

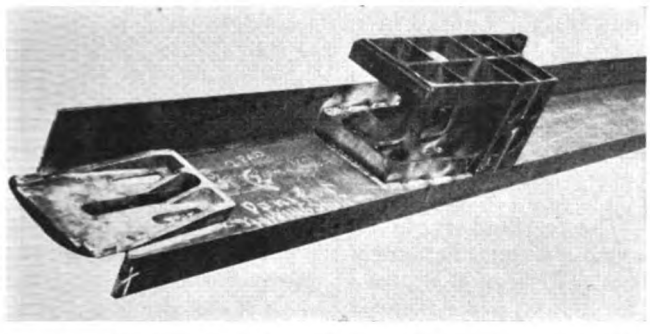
The 5½-in. by 10-in. trucks for this 50-ton box car

have a 5 ft. 6 in. wheelbase and cast-steel double-truss spring-plankless side frames of the integral-box type, furnished by the American Steel Foundries. This company also furnished the cast-steel truck bolsters to which are riveted Stucki roller-type side bearings. The foundation brake rigging includes A. A. R. No. 15 A. S. F. brake beams and Schaefer forged bottom connections and truck levers. The trucks are equipped with Alco top and bottom steel spring plates; Alco A. A. R., 1936, Class D-2 springs and Cardwell-Westinghouse friction-type spring snubbers.

The 40-Ton Refrigerator Car

The steel shell of the refrigerator car is built on the principle of welding subassemblies on jigs, as was described for the box car; however, these subassemblies of the refrigerator car, that is, the underframe, sides, ends and the roof, are assembled by riveting. It is understood, however, that assembly of both the box car and the refrigerator car can be completed by welding or riveting the subassemblies, as desired by the customer.

In general the underframe follows the design used in the box car just described, with the exception that, in

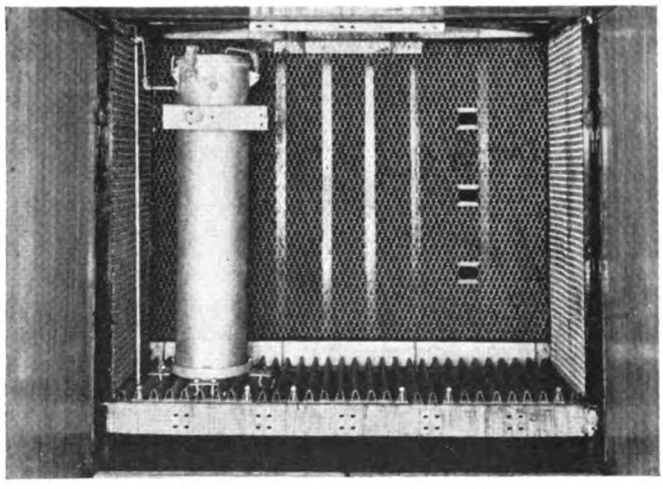


Buckeye combined rear draft lug and center filler castings are used in the center sill of the refrigerator car

the refrigerator car, the combined bolster center filler and rear draft lugs are the Buckeye skeleton type of alloy cast steel instead of being built-up of H-beams and plates as described for the box car. As in the box car, the bolsters, crossbearers and crossties are pressed and rolled low-alloy high-tensile-steel sections of all-welded construction. The side construction of the refrigerator cars is also the same as that described for the box cars with the exception that 4-in. by 3-in. by

Principal Proportions and Weights of the 40-Ton Alloy-Steel Refrigerator Car

Length over corrugations on steel ends, ft. and in.	41- 2⅝
Length inside of lining, ft. and in.	39-10⅞
Length between bulkheads, ft. and in.	33- 2¾
Width inside of lining, ft. and in.	8- 3
Height top of floor covering to ceiling, ft. and in.	7- 9
Height top of floor rack to ceiling, ft. and in.	7- 3
Available cubic capacity between ice bunkers:	
Above floor racks, cu. ft.	1,988
Total, cu. ft.	2,130
Capacity of both ice bunkers, lb.	10,000
Length over end sills, ft. and in.	40- 8⅜
Length over striking castings, ft. and in.	41- 8½
Width over side sills, ft. and in.	9- ½
Width over side sheathing, ft. and in.	9- ⅝
Width over eaves, ft. and in.	9- 4¾
Width, extreme over side ladders, ft. and in.	9- 8⅛
Distance from center to center of trucks, ft. and in.	30- 8½
Height from top of rail to center line couplers, ft. and in.	2-10½
Height of side door opening, ft and in.	7- 4¼
Width of side door opening, ft. and in.	4
Height from top of rail to eaves, ft. and in.	12- 4 1/16
Height from top of rail to top of running boards, ft. and in.	13
Lightweight of car complete with trucks, lb.	44,200
Truck journals, in.	5 × 9



Dry-ice container in the ice bunker

¼-in. rolled angle side sills are used. The doors of the refrigerator car are made up of ⅛-in. pressed-angle stiles and rails to which are welded 16-gage door sheets; Miner lightweight door fixtures are used.

The ends of the refrigerator car are of the builders' corrugated type developed for the box car. The sides of the car ends are flanged to a 3-in. radius and are riveted to the ends of the steel side sheathing.

The roof of the refrigerator car is of the same turtle-back design and construction described for the box car, with the exception that the carlines are spaced on 3 ft. 4 in., instead of 3 ft. 5 in. centers. The running boards are of the same design used on the box car.

The refrigerator car is equipped with Barber Stabilized trucks, Type S-2, with cast-steel double-truss spring-plankless side frames of the integral-box type, furnished by the Buckeye Steel Castings Co. This company also furnished the cast-steel truck bolsters to which are riveted Stucki roller-type side bearings. The only modification in the side frames for these Barber Stabilized trucks is a recess of ⅜-in. in the columns to permit the application of ⅜ in. spring-steel wear plates, after the application of which the side frame conforms to A. A. R. interchange requirements. The ends of the bolsters are changed to provide pockets for the Barber friction castings. Increased spring capacity is provided by this stabilizer because of frictional build-up between the friction castings and wear plate, which also prevents springs going solid. The trucks are also equipped with top and bottom steel spring plates and A. A. R., 1936, Class C-2 outside coil springs furnished by Alco. The foundation brake rigging includes A. A. R. No. 15 Creco brake beams and Schaefer forged bottom connections and truck levers.

Refrigerator-Car Insulation

The bottom course of insulation applied on the ⅝-in. blind floor is a 2-in. blanket of Fiberglas faced with muslin, and covers the full width and length of the car in one piece. The top course of insulation is in panel form of 2-in. Fiberglas covered on both sides with Sisalkraft paper and fits snugly between the floor nailers.

In this car one side and end is insulated with Johns-Manville Stonefelt and the other side and end with Fiberglas furnished by Gustin-Bacon. The sides and ends are insulated with two courses of 2-in. Stonefelt or Fiberglas applied in panel form. Panels are made up of a Celotex backing to which the Stonefelt or Fiberglas is cemented; this construction enables repairs to be made to the steel sides in case of necessity without

removing the side lining. By applying the lining vertically, the boards at the damaged panel need only be removed.

The roof insulation consists of an upper course of 2-in. Stonefelt in blanket form and a lower course of 2½ in. in panel form. This is made up of Johns-Manville Stonefelt and Celotex.

The insulation for the side door consists of two courses of 2-in. Fiberglas muslin covered in panel form.

Partial List of Materials and Equipment on the a. c. f. 50-Ton Box and 40-Ton Refrigerator Cars

BOX CARS

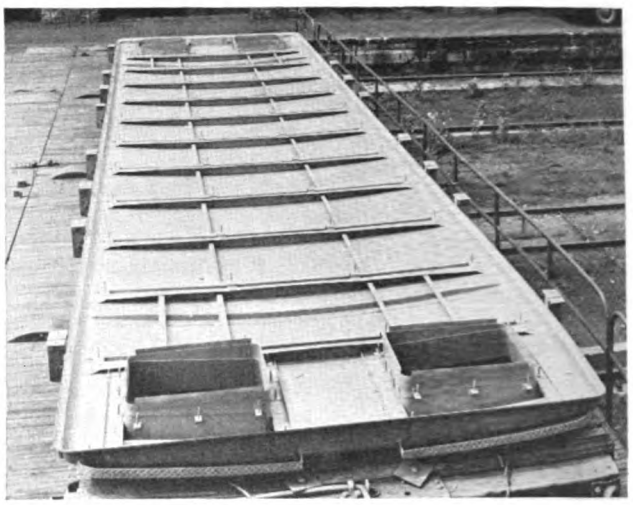
Underframe and superstructure steel, Cor-Ten	Carnegie-Illinois Steel Company, Pittsburgh, Pa.
Side frames; truck bolsters	American Steel Foundries, Chicago
Bottom connections; truck levers	Schaefer Equipment Company, Pittsburgh, Pa.
Side bearings	A. Stucki Co., Pittsburgh, Pa.
Hand brakes; wheels	American Car and Foundry Company, New York
Springs; spring plates; journal-box lids	American Locomotive Co., Railway Steel Spring Div., New York
Axles	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Journal bearings	National Bearing Metal Corp., St. Louis, Mo.
Couplers; coupler yokes	Buckeye Steel Castings Company, Columbus, Ohio
Uncoupling device	Union Metal Products Company, Chicago
Draft gear; spring snubbers	Cardwell Westinghouse Company, Chicago
Air brakes	Westinghouse Air Brake Co., Wilmerding, Pa.
Brake shoes	American Brake Shoe & Foundry Co., New York
Brake beams	American Steel Foundries, Chicago
Side door fixtures	Chicago Railway Equipment Co., Chicago
Defect card holder	MacLean-Fogg Lock Nut Co., Chicago

REFRIGERATOR CAR

Underframe and superstructure steel, Cor-Ten	Carnegie-Illinois Steel Company, Pittsburgh, Pa.
Side frames; truck bolsters	Buckeye Steel Castings Company, Columbus, Ohio
Hand brakes; wheels	American Car and Foundry Company, New York
Axles	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Springs; spring plates; journal-box lids	American Locomotive Co., Railway Steel Spring Div., New York
Journal bearings	National Bearing Metal Corp., St. Louis, Mo.
Couplers	Gould Coupler Corp., Depew, N. Y.
Coupler yokes	Buckeye Steel Castings Company, Columbus, Ohio
Uncoupling device	Union Metal Products Co., Chicago
Draft gear	W. H. Miner, Inc., Chicago
Bottom connections; truck levers; wear plates	Schaefer Equipment Company, Pittsburgh, Pa.
Stabilizers	Standard Car Truck Co., Chicago
Center filler and rear draft lug	Buckeye Steel Castings Company, Columbus, Ohio
Air brakes	New York Air Brake Co., New York
Brake beams	Chicago Railway Equipment Co., Chicago
Brake shoes	American Brake Shoe & Foundry Co., New York
Side bearings	A. Stucki Co., Pittsburgh, Pa.
Door fixtures	W. H. Miner, Inc., Chicago
Side-door threshold; waterproof floor	Johns-Manville Sales Corp., New York
Door packing	American Car and Foundry Company, New York
Insulation:	
Stonefelt	Johns-Manville Sales Corp., New York
Fiberglas	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Board panels	Celotex Corporation, Chicago
Hatch covers	Alan Wood Steel Co., Conshohocken, Pa.
Bunker wire (Consolidated Expanded Metal Co.)	Wheeling Steel Corp., Wheeling, W. Va.
Defect card holders	MacLean-Fogg Lock Nut Co., Chicago

The hatch plug is insulated with two courses of 2-in. Stonefelt.

The inside lining consists of $^{25}/_{32}$-in. by 3¼-in. tongue-and-groove fir applied vertically on sides and ends. The side lining is nailed to 1⅝-in. by 2½-in. yellow-pine horizontal furrings bolted to side posts; the end lining is nailed to 1⅝-in. by 2½-in. yellow-pine horizontal furrings bolted to clips, fusion welded to the steel car end.



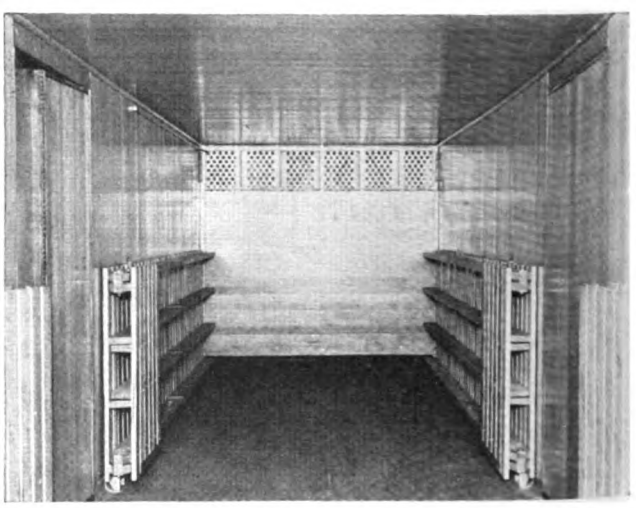
Welded turtle-back roof inverted to show structural details

The ceiling is formed of $^{25}/_{32}$-in. by 3¼-in. tongue-and-grooved fir applied transversely of the car and nailed to 2⅜-in. by 2½-in. yellow-pine roof purlines bolted to clips, fusion welded to the roof carlines.

The floor consists of 1¼-in. by $5^{1}/_{16}$-in. tongue-and-groove fir laid transversely and spiked to the floor nailers. Over this floor is applied Johns-Manville membrane flooring.

The Ice Bunkers

The ice bunkers, of builder's design, have floor pans which are continuations of the Johns-Manville membrane floor. Perfection drains of galvanized steel, and a c f



The refrigerator car interior

well traps of galvanized pressed steel are used. The ice-grate support is built-up of pressed low-alloy high-tensile-steel sections fusion welded together to form a single unit. The ice-grate support is carried on shelves at the side of the car, which are a part of the car framing. There are three ice-grate sections in each bunker, which sections are built-up of ⅛-in. inverted-V pressed grate bars fusion welded to $^{3}/_{16}$-in. grate-bar ties. These sections are bolted to the supports and are removable.

The bulkhead unit is made up in three sections—two side and one center section—each completely finished be-

(*Continued on page 475.*)

The Evolution of

The Locomotive in France

By Lawford H. Fry

A review of La Locomotive á Vapeur* by André Chapelon†. This book contains 914 pages and 14 folding plates

IT seems eminently proper to say that Mr. Chapelon's "La Locomotive á Vapeur" (The Steam Locomotive) is a monumental work. Its size alone, 900 pages, 9 in. by 11 in., weight 10 lb. avoirdupois, would justify the adjective. In addition, the text is a very valuable contribution to our organized knowledge of the locomotive. The chapters describing recent improvements in the Paris-Orleans-Midi locomotives and the thermodynamic foundation for these changes should be required reading for every American locomotive designer. As assistant chief engineer of design of equipment of the Paris-Orleans-Midi Railway, Mr. Chapelon has taken an active part in the design of many of the remarkable locomotives he describes, and provides full documentation for the theories on which the designs are based.

The book is essentially an account of the development of the steam locomotive in the last thirty years. The various types which have been used in Europe and America are described and illustrated and general dimensions are given. Other chapters deal at considerable length with the basic thermodynamic conditions which control the operation of the steam locomotive. In the present writer's opinion this is the most valuable part of the book. Details of construction receive very little attention, and except for the descriptions and dimensions of the various types, Mr. Chapelon is concerned with the physiology of the locomotive rather than with its anatomy.

To show the scope of the book, the titles of the nine sections of the book are quoted. The number of pages given for each section will serve to indicate the emphasis the author places on each phase of his subject:

		Pages
I	Introduction	10
II	Recent Evolution of the Steam Locomotive	290
III	Thermal and Thermodynamic Studies of the Steam Locomotive	435
IV	Dynamics of the Steam Locomotive	40
V	Power and Tractive Force of the Steam Locomotive	45
VI	Testing the Steam Locomotive	30
VII	Operation of Steam Locomotives	15
VIII	The Design of Steam Locomotives	30
IX	Conclusion (Results at Present and Possibilities of the Future)	3

In the introduction the evolution of the locomotive in France is sketched briefly with photographs to scale showing the progress from Marc Seguin's 4.5-ton 25-hp. locomotive of 1828 to the Paris-Orleans 103-ton Pacific type of 3,700 hp. in 1934. Mr. Chapelon points out that the important thing is not the growth in size, but the growth in power per unit of weight. This is, of course, due to perfection of details giving greater efficiency in steam production and consumption. In French practice an increase is noted from 21 hp. per ton in 1900 to 23 hp. per ton in 1910 and 25.4 hp. per ton in 1931. At this point a great further step was made. The Paris-Orleans after thorough scientific study of the problem undertook the rejuvenation of their four-cylinder Pacific type locomotive. By increasing the superheat, applying an improved exhaust nozzle and front end, and by doubling the cross-sectional area of the steam passages in the low pressure cylinders, the indicated cylinder horsepower was increased from 2,200 to 3,700, this 50 per cent increase being obtained with less than 11 tons increase in weight. The horsepower per ton was increased from 23 to 37, a truly remarkable jump.

Mr. Chapelon took an active part in the development work of these P-O-M locomotives, and a large and important part of the present book is devoted to describing the principles and designs which produced such phenomenal efficiency. As to the guiding idea, we quote in slightly abbreviated form Mr. Chapelon's words:

> What are the deep causes of progress? Real progress requires more than a mere increase in size. Improvement is indissolubly tied to efficiency. The second law of thermodynamics is of the first importance in that science. In developing it, Carnot was not interested in producing the most powerful heat engine. He aimed at producing the most efficient no matter how small the power.
>
> Progress can only be made on a basis of exact knowledge, knowledge which can only be acquired by untiring experiment. In the present case it is easy to show that all the decisive progress has resulted from methodical tests which have been made with the locomotives. That eminent scientist, Henry Le Chatelier, pointed out recently that many working in the hard school of realities become discouraged, lose faith in Science, and turn toward some easy solution, forget how real progress is impeded by acceptance of an easy empirical solution of their problem. In the ancient profession of railroad engineering there is, perhaps, too great a tendency to follow tradition and to be skeptical of science, thus neglecting opportunities for rejuvenation. All should join in a crusade for Science, as this alone will develop the spirit and forge the tools necessary for effective and rapid progress.

Mr. Chapelon speaks warmly and in a good cause. We in America may well consider his views seriously. The steam locomotive cannot develop if we attempt to force new designs into the frame of the old ratios.

The second section is largely given over to pictures or diagrams of recent locomotives of all countries and of all types. Two hundred and twenty-five locomotives built in England, Europe, and America are shown and principal dimensions are given. This section is interesting as showing the diversity of opinions or tastes which guide locomotive designers. It is worth noting that in presenting boiler dimensions only boiler pressure and grate area are given. Mr. Chapelon points out that the power of a locomotive depends in the first place on the rate at which heat can be produced in the firebox, and that for a given fuel and a given thickness of fire this rate of heat production is proportional to the grate area. This is true enough, and for locomotives all burning the same coal the grate area measures the boiler capacity better than the area of heating surface does. However, the locomotives compared range from the English engines burning first class full coking steam

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† Mr. Chapelon is assistant chief engineer of design of equipment of the Paris-Orleans-Midi Railway.

coal to western American engines burning a friable semi-lignite, and under such conditions the grate area alone does not give a true measure of the boiler capacity.

Principles Underlying Recent Evolution

In discussing the principles which underlie the evolution of the steam locomotive in the last thirty years, Mr. Chapelon notes the following tendencies:

Boiler Pressure

In 1907 compound locomotives were working with 225 lb. per sq. in., while superheater locomotives were, through imperfect understanding of the thermodynamics of the situation, using only 170 to 200 lb. per sq. in. Gradually these pressures have increased. In Germany pressures of 285 lb. per sq. in. are now used for single expansions and of 355 lb. per sq. in. for compounds. In France a pressure of 285 lb. per sq. in. is commonly used. In America pressures have been increased somewhat more slowly, but have risen to 250 and, in many recent cases, 300 lb. per sq. in. Mr. Chapelon warns, however, that the use of a high boiler pressure calls for a number of precautions that do not seem to have received sufficient attention. With such pressures the effect of the cylinder walls and leakage may easily take such proportions as to wipe out any gain.

To realize the efficiency made available by high steam pressure, it is essential to use a very high superheat and possibly reheating. At the same time a high degree of expansion must be used, with compounding or triple or even quadruple expansion cylinders. Steam jacketing of the cylinders may also be desirable.

Superheat

Thirty years ago the merits of superheat were still under discussion, with strikingly successful results being reported from Germany. Superheating is now general practice, but the increase in steam temperature has not been continuous. The early German locomotives with short tubes worked ordinarily with temperatures of about 600 deg. F. rising occasionally to 675 deg. F. As the Pacific and Mikado types with their longer tubes were introduced, steam temperatures dropped. The consequent loss of efficiency led to study of the situation. Dimensions were improved and various novel designs of superheaters were tried. At present a minimum steam temperature of 700 deg. F. is aimed at and in some cases temperatures of 750 deg. F. or even 800 deg. F. are desired. The last figure is that for the German State compound with 355 lb. per sq. in. boiler pressure. Mr. Chapelon expresses the opinion that extremely high steam temperatures present no difficulty so far as the boiler is concerned, but require special cylinder lubricants and special cast iron for cylinders and piston rings. Looking to the future he concludes that for a pressure of 285 lb. per sq. in. a temperature of 750 deg. F. is insufficient. Several railroads are experimenting with reheating of the steam between the high and low pressure compound cylinders.

Compounding

The expansion of the steam is discussed at considerable length. It is pointed out that in America single expansion cylinders are used exclusively, but that in Europe compounding is coming back into favor, particularly in France where it was widely used twenty years ago.

Mr. Chapelon is a strong advocate of compounding, because of the greater efficiency. Quoting the results obtained with the rebuilt Paris-Orleans engine for express service, he shows that the highest speeds can be reached provided that the steam passages for the low-pressure cylinders are given sufficient cross-sectional area.

Steam Distribution

Valve motions are discussed briefly, Mr. Chapelon being of the opinion that almost any system will give good results if the piston rings and valve bushings are in good condition. He feels that the effect that can be produced by changing the valve motion to vary the valve events is purely secondary. Cylinder efficiency depends essentially on ample cross-sectional area being provided in the exhaust passages in the cylinders.

A similar line of reasoning is applied to poppet valves. Their advantage does not lie in a more rapid opening or closing of the ports. As advantages can be claimed: (1) Elimination of the necessity for lubricating the steam distributors at high steam temperatures; (2) Poppet valves provide ample steam passages with low inertia effects. In the Paris-Orleans four-cylinder compound with low-pressure cylinders 25.5 in. in diameter with very large steam passages, the moving parts of the poppet valves weigh only about 10 lb. and have a lift of only 1-⅛ in. The reduction in inertia forces in comparison with a piston valve is obvious.

Recent Improvements in French Locomotives

Following very brief notice of boilers, superheaters, and running gear the Section on the recent evolution of the steam locomotive gives a somewhat detailed account of the improvements in exhaust, superheat, and steam passages which were applied to the rebuilt Paris-Orleans locomotives. This chapter and the Section on Thermodynamics which presents the theory justifying the changes in the rebuilt engine provide the real meat of the book. They tell a story which is of sufficient importance to claim a separate chapter of this review. The claim that the indicated horsepower was increased from 2,200 to 3,700 with an increase in weight of only 11 tons is startling, but it is so documented with test data as to be entirely convincing. Details are reserved for comment in a later issue.

Dynamics of the Steam Locomotive

The chapter on the Dynamics of the locomotive provides an interesting survey of the subject. A point of interest is the statement, attributed to Mr. Loewy of the Southwestern Railway of Russia, in 1893, that in a two-cylinder locomotive the forces set up in the frames by the cylinder thrust are not the same on both sides. Mr. Chapelon gives an example showing that with 84-in. cylinder centers and 42-in. frame centers the frame stresses on the side of the leading crank are about 15 per cent greater than the stresses in the frame on the other side.

In discussing counterbalancing of locomotives, the statement is made that longitudinal balance is comparatively unimportant. In support the experience of the German State Railways is quoted. Recently, in order to reduce dynamic augment the balance provided for the reciprocating parts was greatly reduced. As a result the riding of the locomotive was improved.

The external dynamics of the locomotive are dealt with, trackage on tangent and curves being discussed. In the chapter on Power and Useful Tractive Force, train and locomotive resistance are discussed and some of the many resistance formulae are quoted. As a result of many experiments on the road and on the testing plant, it is concluded that in spite of its machinery, a locomotive running light with throttle open has a rolling resistance not noticeably greater than that of a similar

weight of train, and that this resistance is practically unaffected by the number of axles which are coupled.

To provide information as to the loads that a locomotive can handle, attention is given to the limitations on locomotive power that are set by adhesion and by boiler capacity. It is pointed out that for high-speed service it is of the greatest importance to have a high value for the ratio of cylinder horsepower to total weight.

The Sections on the Testing and the Operation of Steam Locomotives are of interest without any very deep study of the subjects.

Thirty-two Horsepower per Ton of Locomotive

The final Section on Design presents designs for several types of locomotives in which the experimental data and the theories developed have been used to produce locomotives of maximum power and of the highest efficiency. Two of the most interesting types are a 4-6-4 to handle 870 tons at 100 miles per hour and a 2-10-4 to handle 4,900 tons at 68 miles per hour. Both engines have the same boiler and are designed to develop 6,000 hp. in the cylinders with a grate area of 75 sq. ft. and total engine weights of 350,000 and 357,000 lb. in working order. These figures represent 80 i. hp. per square foot of grate and 32 hp. per ton of locomotive and are 20 to 25 per cent better than current American practice. They might be considered excessively optimistic if they were not supported by detailed information as to results being obtained today on the French railroads. Starting ten years ago with efficiencies comparable with those of present day American practice, the French are shown by Mr. Chapelon to have studied the subject very closely and then to have obtained in practice the increased efficiency which theory showed to be possible. Important features of design contributing to high efficiency are: ample steam passages from boiler to exhaust; double stack with special exhaust providing high draft with low back pressure; and super-heater giving high steam temperatures with low pressure drop. Improvement of design along these lines seems to be possible for America, and Mr. Chapelon's work may be found to have an important message for American locomotive engineers.

It is hoped to present in an early issue a more detailed review of the theory and practice which have been followed in the recent development of the French locomotives, will be presented in an early issue.

Lightweight Welded Cars

(*Continued from page 472*)

fore placing in the car. The bulkhead header brace is composed of pressed alloy-steel sections fusion welded together—all metal parts are galvanized, while the sides, end walls, and the back of the wood bulkhead are coated with car cement and treated with asphalt-treated felt. The removable wood bulkhead is built-up on a single unit of 1⅛-in. by 5⅛-in. tongue-and-groove fir, framed together with galvanized pressed channels at the sides. The end and sides of the icebox are faced with Steelcrete 1¼-in. Cop-R-Loy bunker mesh. A 4-in. by 4-in. mesh of 0.035-in. diameter galvanized wire screen is provided at the top opening of the bulkhead.

Other Features of the Refrigerator Car

There is one dry-ice container in each bunker at diagonally opposite corners of the car. Each container, of the builder's design, has a capacity of 300 lb., and is so designed that CO_2 gas can be exhausted either into the car or the atmosphere, depending on the character of the lading.

One of the illustrations shows the general arrangement of the container and piping. The container proper consists of an outer cylindrical galvanized steel shell with gas-tight removable charging cover equipped with suitable gasket. An inner shell of square cross-section is placed inside of the outer shell. This square shell is closed at the bottom and open at the top. The dry-ice blocks (a maximum of six 50-lb. blocks) are placed in this inner shell.

The CO_2 gas resulting from the sublimation of the dry ice flows over the open top of the inner shell and fills the space between the outer and the inner shells, thereby helping to insulate the dry ice by means of its own gas. As the gas pressure within the container builds up to slightly less than 1 lb. per sq. in., the check valve in the exhaust pipe lifts and allows the gas to exhaust either into the car proper or to the outside air, depending on the setting of the three-way cock in the exhaust pipe.

The container can be applied to old as well as to new cars as it is inserted through the hatch and rests on the ice grate. In the combination of dry ice and water ice in ice bunkers as developed by the American Car and Foundry Company, tests show a lower uniform temperature to be obtained with less consumption of water ice so that the cost of both dry ice and water ice is lower than the cost of water ice alone as used in a conventional ice bunker. The tests, of course, were conducted under the same condition. The use of this device is optional with the purchaser of the car.

The floor rack, of 1¾-in. by 4⅞-in. fir rails and 1⅛-in. by 4-in. yellow-pine slats, is held in place by hinges which permit raising the rack when cleaning the car. Exposed metal parts are galvanized.

The car is equipped with double-swinging doors which provide a 4-ft. opening. Miner door fixtures and La-Flare packing are used. The doors are also fitted with striking plates and hooks for holding the door open, and with Johns-Manville threshold plates.

The hatch plate and cover, which is of builder's design, has a flexible connection between the cover and the plug, providing sufficient leverage to break the ice seal around the plug. One ice hatch is located at each corner of the car. The hatch cover is of Super Diamond plate, flanged on all sides. The cover and plug can be set in the ventilating position by means of a ventilating bar.

Improved Barber Truck

The original Barber stabilized truck, described in the *Railway Mechanical Engineer* for March, 1934, and known as the Type S-1, was designed by the Standard Car Truck Company, Chicago, to promote easy riding and overcome costly harmonic spring action. This design required a special type of side frame but used the standard design of truck bolsters which were provided with roller pockets when Barber lateral-motion device was desired and several thousand cars using this truck are now in service.

Subsequently, a new design of stabilized truck, known as the Type S-2, was developed and while it did not permit the use of a lateral-motion device, it did enable the use of standard A.A.R. or double-truss types of side frame and with only a slight change in the ends of the truck bolsters. With this improved design, shown

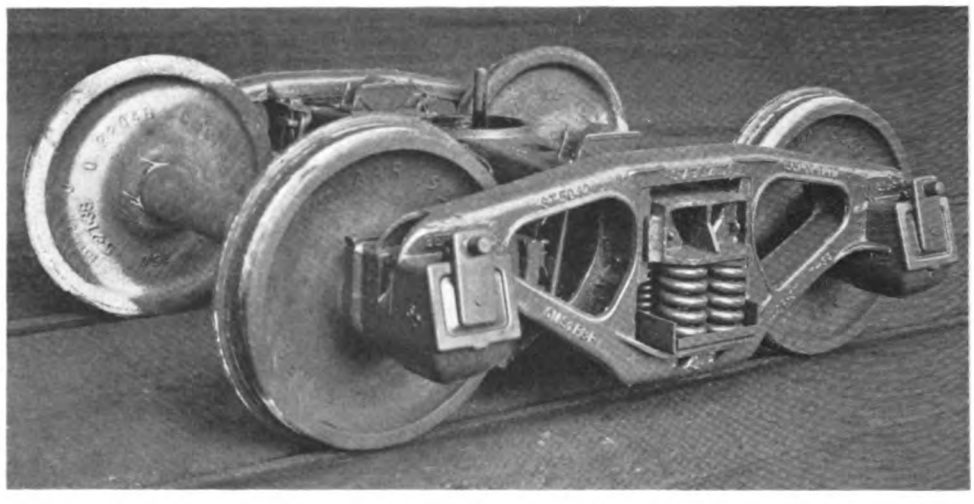
in the schematic drawing, the only modification in the side frame is a recess of ⅜ in. in the columns to permit the application of ⅜-in. spring steel wear plates and after these wear plates are applied, the side frame conforms strictly to A.A.R. standards.

The slight change necessary in the ends of the bolsters is to provide pockets to receive the friction castings. These castings are of special alloy friction iron and each has an area of 36 sq. in., giving a combined area of 72 sq. in. per frame of contact with the column wear plates. This results in an extremely low pressure per square inch and provides the means of breaking up the truck spring oscillations by the control of the bouncing action. It also means an easy riding car, thereby reducing damage claims to a minimum and reduces car maintenance expense. Increased spring capacity is also provided when most needed because of the frictional build-up between the friction casting and wear plate, therefore, the springs do not go solid and cause spring breakage.

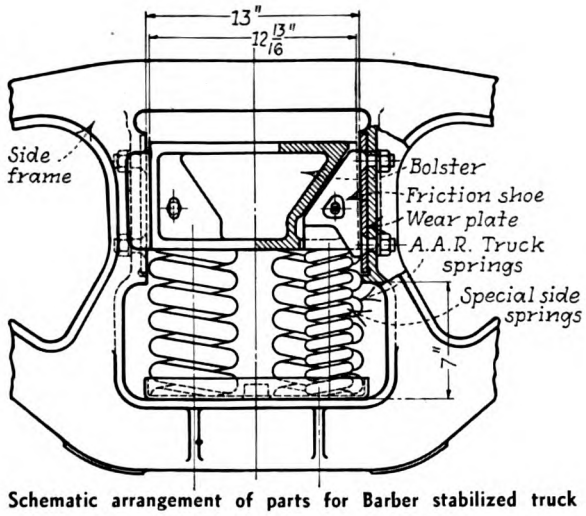
One of the outstanding features of this truck is the elimination of the customary wear on bolsters and side-frame columns and because of its unique construction it eliminates all looseness between these members.

This truck also provides for the use of standard A.A.R. truck coil springs but saves the furnishing of eight inner coils; the manufacturer supplies eight springs of slightly higher capacity than standard inner coils and each of these springs supports a friction casting. These springs are slightly longer than the truck springs but made with the same solid height and, due to this extra length, there is said always to be sufficient compression to retain the friction block in tight contact with the bolster and column wear plate. This extra length of side springs also provides a means for taking up automatically, any slight wear that may develop on friction castings due to years of service. With this truck it may also be said that only four spring plates per car are required and these can be either the universal or plain non-patented type, manufactured by either the railroad or the car builder.

Still another outstanding advantage claimed for this truck is the graduated pressure exerted between the friction block and wear plate, dependent upon the load in the car. Purdue tests show that, with an empty car or, in other words, with only the weight of the car body, the pressure between the friction block and wear plate is approximately 20 lb. per sq. in., which increases in proportion to the load. The maximum pressure under a fully loaded car amounts to 65 lb. per sq. in. of frictional area. This design tends to provide for easy or smooth riding, regardless of the amount of load in the car.



Improved Barber Type S-2 stabilized truck which is designed to cushion vertical shocks in proportion to the load



Schematic arrangement of parts for Barber stabilized truck

CAR MEN MARK 50TH ANNIVERSARY.—The Brotherhood Railway Carmen of America this month is commemorating the 50th anniversary of the organization of its predecessor union, the Brotherhood of Railway Car Repairers of North America, at Cedar Rapids, Iowa, October 28, 1888. According to the current issue of the "Railway Carmen's Journal," seven car repairers met in an unused combination baggage and smoking car of the Burlington, Cedar Rapids & Northern (Chicago, Rock Island & Pacific) on that date and formed the first lodge. The present organization was formed in September, 1890, by the union of the original organization and the Carmen's Mutual Aid Association. Highlights of the preamble and declaration of members of the union which were adopted at the first convention at Topeka, Kansas, included the following aims of the brotherhood; "first, to exalt the character and increase the efficiency of carmen, to bring greater proficiency into their department by a mutual interchange of ideas and a discussion of the best and most economical methods of performing labor; second, to benefit our employers by raising the standard of our craft; third, to establish mutual confidence and create and maintain harmonious relations between employer and employee; fourth, to care for our dear ones in distress or when disabled or removed by accident or unavoidable adversity."

EDITORIALS

One Effect Of Seniority

In these days of reduced forces and short working hours supervisors are faced with many problems in their struggle to keep up with the minimum demands that must be satisfied if rolling stock is to continue to operate safely. One of the annoying conditions with which they must deal is the constant shifting of men as forces are expanded or reduced. No sooner have men become familiar with the duties of their assignments than they are "bumped" or laid off.

Not only is this annoying; it is a wasteful and, in some respects, hazardous. Let it be admitted that most of the mechanics, particularly those in the enginehouse, have had an all-around training. Nevertheless, when assigned to trouble shooting on some particular parts of the locomotive and its appurtenances, time, coaching and study are required before an expert degree of proficiency can be developed. Where this proficiency is lacking work reports may be repeated many times before the real seat of the trouble is located.

Thus is caused an unfortunate waste of effort at the very time when man-power resources are already inadequate. Another unfortunate aspect is the bearing such a condition may have on the development of disastrous locomotive failures, such as the crown-sheet failures referred to in these columns last month.

Continuous Training

"We have only recently begun to . . . realize that the real task of education is not to bring children to the last grade of the common school, or even to carry them through high school. We have come to learn that even the enormous expansion of the number of our children who will actually obtain the benefits of university education is not enough. The real educational problem is to provide that the whole of our people shall throughout their lives be able to carry on the education which is automatically lifelong, with the assistance of skilled teachers and proper facilities." Thus spoke Sir Edward Beatty, chairman and president of the Canadian Pacific Railway, at the Triennial International Transportation Conference of the Y. M. C. A. of North America, recently held in Toronto.

The remarkable growth of the adult education movement in recent years is probably due to two factors. In the first place, shorter working hours have made it possible for more and more adults to attend the evening classes and to profit from them either in broader culture or greater skill in their occupations. Of still greater importance, however, is the fact that the introduction and development of new products, new materials and new methods of fabrication, has called for better training and more expert knowledge on the part of the supervisors and workers in all industries. Labor-saving machinery in accounting and office work, for instance, has in many cases replaced slow and tedious processes; at the same time it has required a different sort of training and ability to handle these new devices.

The railroads in this country have never recognized the importance of the continuous education and training of their employees to the same extent as have the railroads abroad. Even the training of shop apprentices, except on a very few roads, has been a more or less haphazard process and little if any systematic attention has been given to the training of the workers after they have become journeymen. Is this not a serious mistake, and ought not special attention be given to Sir Edward Beatty's challenge by the heads of all the departments of our railroads, and particularly by the mechanical department?

The past few years, in spite of the depression, will stand out in the history of the railroad mechanical department because of the introduction of new materials, of new designs of equipment, and of improved machinery and equipment available for maintenance and repair processes. How much attention is given to training the supervisors and the workers in the use and operation of these new products and machines, which in many instances differ radically from those which they are superseding—and we are only just at the beginning of a far more widespread use of such things. Certainly the younger men, or those in middle age, should be given the opportunity to increase their knowledge and improve their abilities to deal with these improvements.

And how about the men who have passed middle age? Are they to be thrown on the scrap heap, as some of them now are, or be allowed to work inefficiently because of lack of training, a reasonable amount of which will enable them to improve their production and give satisfactory service? One of the most pathetic experiences that one can have is to run across men in good physical condition, whose spirit is broken because their jobs have outgrown them. What greater service could a labor union render its members than to assist in finding ways and means of arranging for continuous training for the workers throughout their service life? Railroad managements undoubtedly will benefit greatly by assisting their employees to maintain their working efficiency at a reasonable high standard. Possibly the public school system and other agencies, which

have already set up adult training courses, can in some way co-operate in the technical training required by railroad workers. Certainly some of the Railroad Y. M. C. A. secretaries who were inspired by Sir Edward's discussion of adult education, will be glad to do what they can to co-operate in this respect.

Time To Pull Together

The wage controversy is over. However discouraging to the managements the conditions which caused them to withdraw the wage reduction may be, they have, by that act, removed a cause of serious demoralization in the relations between employees and managements.

Whatever opinion one may hold as to the merits of the case of the railroads for the proposed wage reduction—we believe it was a good case—one cannot but regard the situation of the employees with sympathy, particularly those in the shops, enginehouses and repair tracks. To face a reduction of personal income is always disturbing. In the face of the utmost uncertainty as to the number of hours per month one may be permitted to work or, indeed, as to the permanency of any job at all, the prospect of a wage reduction becomes sufficiently desperate to give subversive leadership an opportunity to do its worst in destroying all bases for understanding between management and men.

In withdrawing the wage reduction the railroads were led to hope that both government and the labor organizations would cooperate actively in developing a constructive program of legislation to mitigate some of the current difficulties of the industry. The future alone can disclose how well justified this hope may be. The utmost skepticism as to the outcome of this organized cooperation, however, should not blind one to the very real possibility of restoring an atmosphere of confidence and cooperation between each individual employee and his particular management. Let it be the purpose, first, of every management and every supervisor, and then of every man in the ranks to restore such an atmosphere.

As long as men expect to make their careers and their living on the railroads they have a stake in the welfare of the industry greater in the aggregate than that of the bondholders or the stockholders. In 1929, the last year of pre-depression prosperity, the aggregate compensation of employees of the Class I railways amounted to 46 per cent of total operating revenues; in 1933, the year in which aggregate wage and salary payments were the lowest, they still amounted to 45.5 per cent of total operating revenues, although in amount they were less than half the payments of 1929. In 1937, partly as the result of wage increases, employees received a slightly increased proportion of total operating revenues—47.5 per cent. Still the total amount was 31 per cent less than in 1929 because total operating revenues were 33.5 per cent less. Bond and note holders, who received in interest 8 per cent of total operating revenues in 1929, received more money in 1933—16.6 per cent of total operating revenues—and less money in 1937, although the 11.5 per cent of total operating revenues was still proportionately high. Dividends, which took almost 8 per cent of total operating revenues in 1929, were reduced in amount to less than 20 per cent as much in 1933, were still but about 40 per cent as large in 1937, and took but four per cent of the total operating revenues of that year.

Certainly these facts point to the vital interest of employees in the general welfare of the railway industry. No amount of struggle for a redistribution of the operating revenues can compensate for the adverse effect on the welfare of employees as a whole of a continued decline in revenues. Furthermore, those employees who resent the amount paid out by the railroads as interest on debt should observe that only by a return of prosperity to the industry can the amount thus disbursed be reduced. The highest interest payments during the depression were in 1933 when the curtailment of employment was at its worst. Unbalanced budgets on the railroads, just as in government or in the household, led to increased debt and increased the drag of interest payments.

But how can employees influence the prosperity of the railways? Through a restored fighting morale permeating the entire organization. There was a time, when railways were a transportation monopoly, that morale meant little in increasing the business of the railroads as a whole, although it might mean much in competition between railroads. Now, with subsidized transportation agencies in strong competition with the railroads, it is vital to the future of the entire railroad industry that it be on its toes to cut costs and improve service if it is not to see a continued reduction of its proportion of the total transportation business of the country, with an accompanying loss of opportunity for employment in its service.

With the immediate cause of demoralization removed every supervisor who believes in his job will, in his own self interest, do everything in his power to restore a fighting morale throughout the organization of which he is a part. Then will the hope which led the managements to withdraw the wage reductions, at least in part, be justified.

The Railroads and The Apprentice Problem

One of the railroad programs which has been most neglected during the depression period since 1929 is that of apprentice training. Upon a gradual return to normality, with adjustments in maintenance practice necessitated by improvements in motive power and

rolling stock, and in the equipment required for their maintenance, as well as by improved practices in shop operation learned during periods of economic stress, the question arises as to what attitude the railroads are going to assume toward the training of apprentices. There is no doubt but that this problem is one of the easiest to side step. Although many railroad officers in the past and at present have approached the subject with a friendly attitude, there have been many others who blindly refused to believe that such training is of benefit both to the apprentice and the railroad and that it can be conducted without great trouble and expense.

Some railroads, which prior to 1929 maintained an apprentice system comparable to the best of those found in other industries, have taken no steps to rebuild it to its former high standard. This is true notwithstanding the fact that many of their best mechanics are their own apprentice-trained men. The present trend in shop practice encourages the development of specialists rather than all-around skilled mechanics; this has been one of the factors working against the restoration of apprentice training to its former high standard. This fact, in addition to others, such as expenses involved in training men who may ultimately resign after being trained, and the cost of apprentice supervision and schools has undoubtedly had its influence in retarding the interest in apprentices which was growing steadily before the beginning of the depression.

If the railroads wish to maintain a high standard of workmanship in their shops and to have the services of men with a deep personal interest in the railroad's maintenance problems, they must take a more forward looking attitude toward the training of men not only as mechanics but also as future supervisors and administrative officers. More today than ever before there is a crying need for trained men with exceptional abilities in these capacities. A well-rounded apprentice training program is one of the best means of attracting such men into the ranks and starting them on the road to meet these higher responsibilities.

The principles of a sound apprentice system are well set forth by Warner Seely, of the Warner & Swasey Company, Cleveland, Ohio "Execution of the actual training program," he says, "presupposes a careful analysis of shop training opportunities available for the gradual development of skill; a thorough understanding of related subject matter which trainees will have to learn to meet the needs of the particular employer; and a recognition of the need for training in broader social and economic fields, without which proper balance cannot be insured. Given a proper understanding of all these elements, it is possible to establish an all-embracing program, with standards fixed to maintain fundamental requirements but allowing flexibility enough to accommodate individual capacities, unusual skills, and particular interests. Such standardization does not mean regimentation in any sense. It merely insures performance by trainees at a level which accomplishes the training objective and returns a quantity of productive work sufficient to support and immediately justify the program."

The railroads as well as other industries cannot shirk their obligation to train and develop young men for a productive and a useful life. This in no way infers that such an obligation is being side stepped, but merely that perhaps it is not realized to its fullest extent. Although public schools and governmental agencies are increasing the scope of their activities in the field of industrial training, industry itself should take the initiative and organize its own internal training programs. Many industries other than railroads have in recent years made tremendous advances in the training of carefully selected men who manifest superior mental qualities and manual skill, thereby striving toward a more intelligent mobilization of the capacities of the men they select to train. By the law of averages, such carefully selected men will yield some who will advance beyond the specialties of skilled mechanics and develop the capacity for leadership.

Many of our railroads are still maintaining apprentice systems in some form or other; however, some of them are apprentice systems in name only. They have no predetermined or rigid schedule of work which is so necessary if adequately skilled mechanics with a well-rounded-out shop experience are to be turned out. Others, while making some effort toward systematic routing of apprentices through the various departments of the shops, have no school or other instructional facilities. There are truly no half-way measures. Real apprentice training requires high standards of shop experience, education and supervision.

New Books

STRUCTURAL ALUMINUM.—*Published by the Aluminum Company of America, Pittsburgh, Pa. 5½ in. by 8 in.; imitation-leather bound. Price, $1.25.*

Progress in the manufacture of aluminum alloy structural products and in the design and fabrication of structures employing these products is reflected in this second edition of the Aluminum Company's handbook on structural aluminum. The book presents fundamental information regarding the ultimate strength of structural members fabricated from aluminum alloys, based on laboratory investigation, field tests and extensive practical experience. A section containing commercial sizes, tolerances and specifications has been added; the tables of elements of sections for structural shapes have been expended, and values for torsional constants, with notations on the present availability of sections, have also been added. Elements of sections for rectangular shapes and for tubes have been included and arranged to facilitate computation. The calculations involved in the preparation of the book are based upon theoretical cross sections as shown in the tables.

THE READER'S PAGE

Piston Rod Failures

To the Editor:

In connection with the interesting remarks on Piston Rods and Crossheads, by "Foreman" in your January issue, (page 13) and Frank Rattek in the June number, page 225, it is noticeable that both gentlemen attribute failures to what may be called poor quality of fits. This is true, and a liberal use of the hammer will not overcome an initial poor fit, either in the taper end of the rod, or in the key.

Many crossheads, particularly of older engines, have the taper socket bored right through, and the rod is specified to have a definite amount of "draw" which the key is supposed to take up. With such construction the stresses induced may be anything, but will certainly be of increasing order every time the key has to be tightened.

The British fitting practice appears to have definite advantages; the taper socket of the crosshead has a carefully machined shoulder at the small end. The key slot is milled out undersize, in both rod and crosshead. The rod is then pressed in until the small end "bottoms" against the shoulder in the crosshead socket, at a definite specified pressure. The key slot is then broached out to finished size, with a reciprocating broach somewhat narrower than the rough machined slot. The key is then fitted in solid.

I have before me a drawing of a piston rod for 19-inch cylinders of the three-cylinder Pacifics of the London and North Eastern; the taper of the rod is $\frac{3}{64}$ inch per inch diameter and the taper of the key 1 in 30. The fit calls for the rod to be pressed up solid at the bottom of the socket with pressure of 50 tons, the key slot broached out in place, and the key fitted solid. With a known initial holding force, which in this particular case is nearly twice the maximum piston thrust, the key would appear to be relieved somewhat from load, and having a bearing throughout its length will have better holding power, without excessive use of the hammer.

H. J. Coventry.

Poor Workmanship the Cause of Many Failures

To the Editor:

F. H. Williams' articles on the service failure of locomotive parts are, to say the least, interesting and informative, especially when he calls attention to the fact that improper fits resulting from poor workmanship are the causes of many such failures. However, the writer would like to call attention to the fact that improper workmanship cannot always be recognized as such, and the mechanic will insist that his work cannot be better and in this opinion will be backed up by his supervisor. In support of this statement the writer gives the following three examples of many which could be quoted.

A few years ago we were encountering an excessive number of service failures of piston rods, the failure occurring at the large end of the crosshead taper fit. Supervisors and mechanics alike insisted that failure was due to poor materials although those being used were the best that money could buy and conformed to chemical and physical properties established by our test department. Upon investigation, the mechanic on the job and his supervisor pointed with great pride to the method employed in making the fits. The crosshead was being drilled and presumably tapered $\frac{3}{4}$ in. per ft. on a vertical boring mill, after which the large diameter of the hole was calipered and the taper on the piston rod machined $\frac{3}{4}$ in. per ft. from this measurement. More care on this job could not be taken, we were told by both the mechanic and his supervisor, but upon investigation it was shown that there was no fit whatever and instead the bearing occurred only at the large end of the proposed fit. Reamers with a taper of $\frac{3}{4}$ in. per ft. were purchased and used for making the crosshead fit, and the old procedure of calipering the large diameter of the hole was followed. Service failures ceased to occur after adoption of this practice.

Another instance involves the tapping of staybolt holes in side sheets. We had been obtaining upward of two years' service from such sheets when suddenly their service life fell to an average of three months, the cause of which was laid to poor materials, although again in this case better quality materials had been purchased. Investigation showed that new staybolt taps, purchased at approximately the same time that the new sheet material had been specified, were without lead, and were being used because improved quality of the tap material gave a vast improvement in the number of holes tapped per redressing of the tool. This same tap material used in a tap with lead, retained the tap efficiency and returned the life of the sheets to that obtained before the introduction of the short no-lead tap. Here again, mechanics and supervisors insisted that poor sheet material and not improper workmanship caused our troubles.

One day not long ago we received a hurried call from a division point asking that new driving-box grease be purchased immediately to avoid tieing up the railroad. It seems that power just out of the shop was running hot, the crown brass freezing to the journal. A representative of the grease company called at the shop the following day and found the crown brasses being turned with 0.001 in. tolerance, and was told that such tolerance was correct by the mechanic on the job. The mechanic was astounded to be told, and shown in turn, that the drawing called for 0.001 in. tolerance per inch of journal diameter.

These examples are not to be taken as criticisms of work done in railroad shops, but merely as a suggestion that when failures do occur it might be well to investigate thoroughly the practices of machining or fabricating the part in question.

S. M. P.

Worn-Through Chill Spots Detected by Color

To the Editor:

In your December 1937 issue, "Informal Discussion of Car Questions," I noted the question as to how a worn-through spot could be recognized. The answer was a reference to the wheel and axle manual which is correct of course. There is another way to identify the above defect which seems to me to be as effective and that is to note the color of the iron in a worn-through chill spot. It is a dull gray of a coarser texture than the chill of the wheel.

I wonder how many foremen and inspectors use this method?

Smith W. Dobson.

With the Car Foremen and Inspectors



Fig. 1—Riveting a coal-car side with a Hanna portable riveter at the Decatur steel-car shop of the Wabash

Decatur Shop Devices

A number of shop devices which greatly expedite work at the Wabash freight-car shops, Decatur, Ill., are shown in a series of six illustrations accompanying this article. At present, along with other work, a series of 55-ton twin-hopper coal cars is being given extensive repairs and rebuilding at this shop at a rate of four cars a day. As reconstructed, these cars will have practically all new copper-bearing steel bodies applied on the original underframes, center sills and body bolsters. Murphy panel sides are being installed. The trucks also have new cast-steel side frames.

At the station where car sides are assembled and fabricated by riveting, as shown in Fig. 1, a riveting pit is provided, equipped with a powerful pressure riveting machine. The depth of the pit is not sufficient, however, to permit applying the top row of rivets on 7-ft. high coal car sides, and to use the stationary riveter mentioned would necessitate suspending the car side upside-down from the overhead trolley in order to bring the row of rivets at a level with the riveting head. To avoid

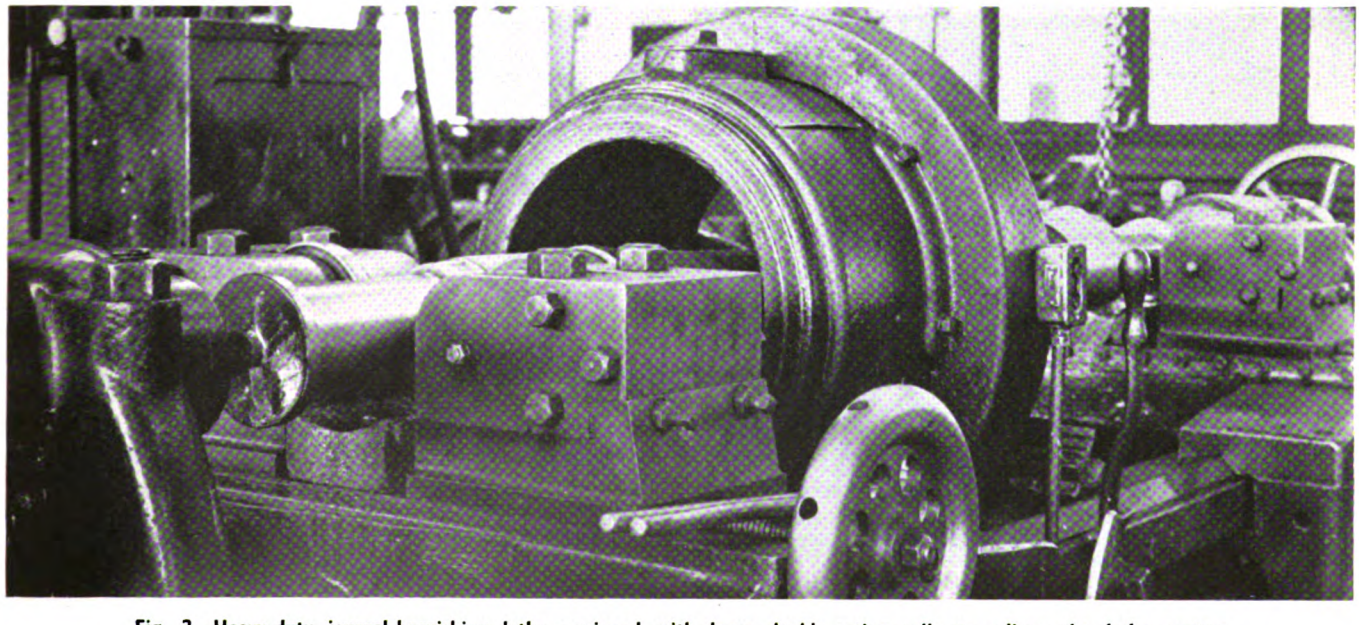


Fig. 2—Heavy-duty journal-burnishing lathe equipped with large double-acting rolls to relieve the lathe centers

this rather awkward handling and time consumed in reversing the car sides, a Hanna portable pinch-bug riveter is supported from the overhead trolley, as illustrated, for applying the rivets to the stationary car side which rests on the bottom of the riveting pit, thus bringing the top of the car side at the proper height above the shop floor for the convenience of men who are performing the riveting operation. The pressed-steel side panels used in constructing these car sides are shown in the foreground of the illustration.

In Fig. 2 is shown an unusually satisfactory machine set-up for rolling car journals. The old center-drive axle lathe has in effect been rebuilt into a journal-burnishing machine which does an exceptionally good job in a minimum time. The two single-post tool carriages, applied on the original machine, were removed and replaced by new carriages equipped with large double rolls. Each of the two new carriages is made from a steel casting, machined at the local shop and fitted for application to the lathe. The rugged character of this carriage and its contained parts is well shown in the illustration. The rolls are 7 in. in diameter by 1¼ in. thick, being supported in roller bearings of substantial size. Powerful hand cross feed of the rolls towards each other is provided by a right-and-left feed screw turned by the heavy hand wheel with handle extension. The machine is started and stopped by the conventional electric push-button control, and a quick throw-out friction clutch, operated by a handle at the right, disconnects the longitudinal feed when the rolls have reached the journal fillet.

Car journals, machined at the Wabash wheel-and-axle shop, are first given a light, smooth finishing cut and then rolled on this machine, which finishes both journals on an axle simultaneously and does an unusually accurate and satisfactory job. One of the most important advantages of this double-roll design is that heavy roll pressures may be used without over-heating or distorting the lathe centers.

The draft-gear wagon, shown in Fig. 3, is successfully used at the Wabash shops when dropping draft gears for inspection or whenever it is necessary to remove and reapply them. The wagon consists of a well braced welded steel framework, approximately 36 in. long by 15 in. wide by 20 in. high, which is suitably mounted on three truck wheels. The main wheels at the right are 18 in. in diameter and the 7 in. swiveling front wheel is mounted on an axle pin connected to the wagon handle. The base plate on this steel framework is carried about one inch from the shop floor and supports an ordinary car jack which is used in lowering and raising the coupler yoke and draft gear. As a matter of fact, this draft-gear wagon is equipped with all of the tools necessary in applying draft gears, including hammers, wrenches, wood blocks, various sizes of cotter keys, pinch bar, etc.

The great advantage of the device is that a coupler yoke and draft gear can be loaded on it at any point wherever convenient in the shop, readily moved to the car and pushed in position under the center sill with a minimum of hand labor. The jack also moves with the wagon and does not have to be pushed or pulled about by shop men bent over in a cramped position. In the interests of safety, it is important to block the wagon wheels and use reasonable care in raising or lowering the draft gear, otherwise a painful accident may occur.

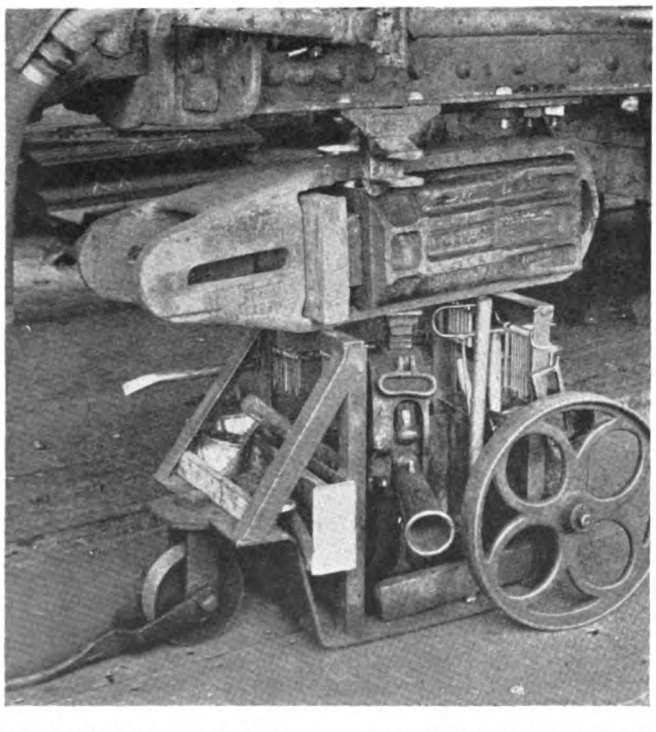


Fig. 3—Draft-gear application wagon used at the Decatur car shop of the Wabash

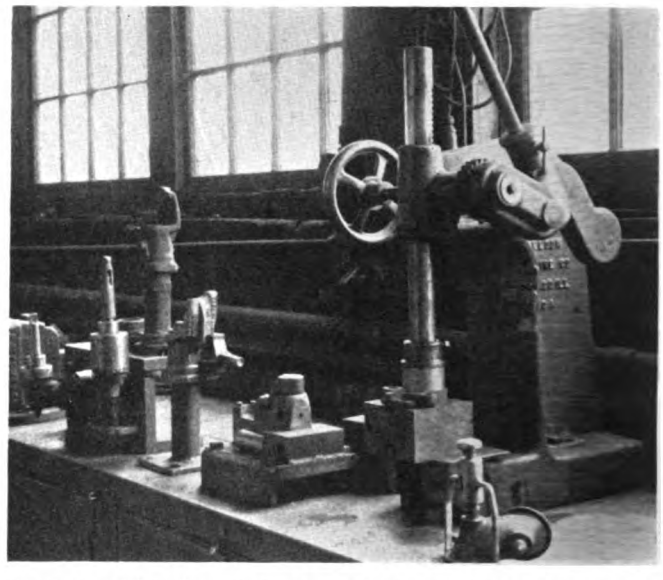


Fig. 4—Special tools and devices used in reconditioning Vapor 2-in. steam-heat connectors

This rather simple hand-operated device is considered superior to some of the pneumatic draft gear-application devices which frequently have sufficient power, with a light car frame, to lift it from the supporting horses and thus introduce a potential hazard.

Several special tools and devices used in the reconditioning of Vapor 2-in. steam-heat connections have been developed, as illustrated. Upper joint bodies are renewed where necessary, new bushings applied in all parts and joints refaced to assure freedom from subsequent leaks. Referring to Fig. 4, there is illustrated, from right to left, a shop-made gage for testing the height of the bearing, a small hand-press used in applying bushings, a special jig for knocking the bearings out of clamps, a master gage for checking the head wear, and a drill-press jig for refacing the joints of various bearings, when worn. This jig is more clearly shown, together with some completed connectors, in Fig. 5.

The drill-press jig is in effect a 6-in. steel channel drilled on the top flange and the side to accommodate the various tops of the steam-heat connector which must

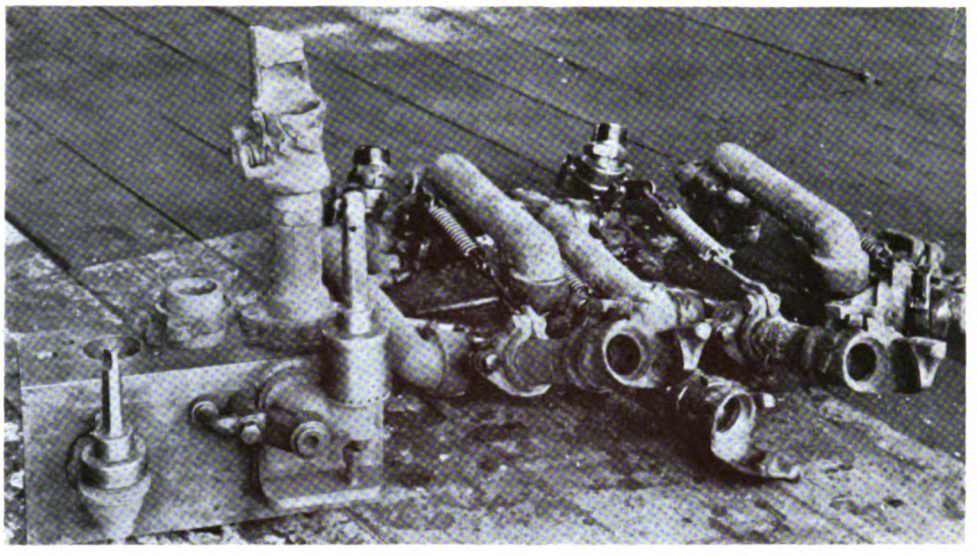


Fig. 5—The drill jig and some reconditioned connectors

be refaced. Standard box reamers and cutters can then be used in the drill press spindle to reface these parts quickly and accurately ready for re-assembly and the application of new bushings.

In cutting stencils for Wabash car equipment at the Decatur shops, the machine shown in Fig. 6, is used to good advantage. This machine, known as a Cutawl K-9 size, is furnished by the International Register Company, Chicago. Electrically operated on 110-volt current, this machine can be equipped with various kinds of cutting chisels and saws which operate vertically at a speed of 3,200 oscillations per minute to cut thin copper, galvanized sheets, fibre and many other materials. The particular advantage of the tool is that it can be hand operated by sliding across the table with the chisel following accurately any desired line, whether straight or curved and practically regardless of how short the radius may be.

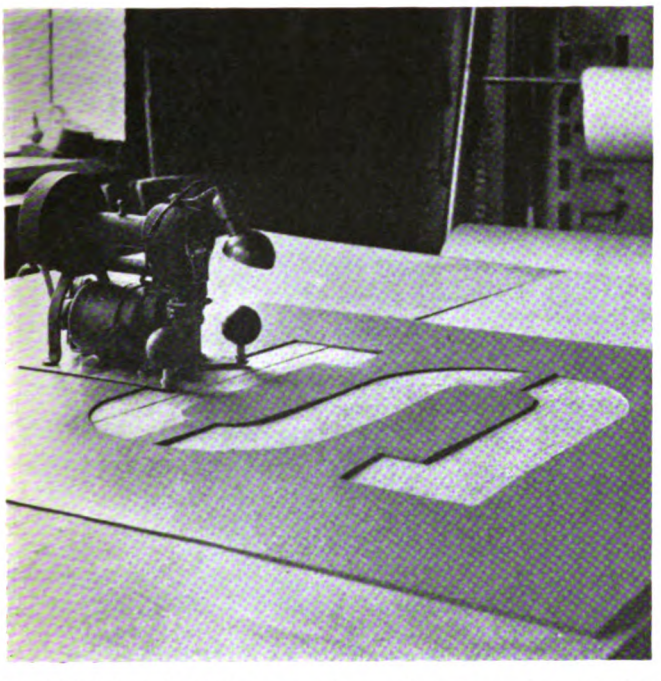


Fig. 6—Modern electrically operated stencil-cutting machine which is both fast and accurate

In cutting stencils with No. 1 red stencil paper it is possible to cut five thicknesses at one time. This permits manufacturing standard stencils in quantity and at minimum cost at one point for the entire system.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Labor Charges Claimed Excessive And Repairs Claims Unauthorized

On April 26, 1935, a Florida East Coast car was damaged to the extent of Rule 44 while being switched on the Clinchfield. The car was interchanged to the Chesapeake & Ohio where it was transferred and returned empty on May 24 to the Clinchfield, which latter road made repairs to the car and returned it to service on May 29, 1935. The car was received at its home line on July 4, 1935, and on September 18, the owner submitted a joint inspection certificate which claimed that the car arrived home in an extensively damaged condition. The owner requested a defect card from the Clinchfield to cover the damages, but the latter furnished a defect card to cover only a part of the items. The owner made repairs to the car on December 9, 1936, and submitted a bill to the Clinchfield on authority of the previously mentioned defect card.

The Clinchfield maintained that the car was not in the condition reported in the joint inspection certificate when it left its line, and took exception to the charge as rendered, contending that certain charges were excessive and that some items had been billed that were not covered by the defect card, which was issued under protest to cover wrong-repair items which were listed in the joint inspection certificate. The Clinchfield pointed out that after it had made repairs to the car in question, the car had moved consecutively from the C. C. & O. to the C. & W. C., from the C. & W. C. to the Southern, from the Southern to the Pennsylvania, from the Pennsylvania to the Southern and from the Southern to its home line.

The Clinchfield maintained that if the car were damaged to the extent maintained in the joint inspection certificate it could not have been moved in interchange on the roads just mentioned; therefore, it maintained that the repairs made by the F. E. C. were not justified on the basis of the defect card issued and the charges made therefor were excessive.

The F. E. C. showed that the Clinchfield had no record of the damage sustained at the time of the accident, and pointed out that the Clinchfield made repairs during a five-day period, one of which was a Sunday, and that before and after repairs were made the car had to be moved a total of 273 miles. The owner maintained that the work in question could not have been done during the five-day period. The owner also produced evidence showing that the car was received on the home line in the same condition reported by the C. & O. when first moved from the Clinchfield after the accident in question. The owner also produced a record of man-hours actually involved in repairing the car and contended that the charges therefor were not excessive.

In rendering a decision on November 11, 1937, the Arbitration Committee stated: "The Clinchfield should issue its defect card to cover all items shown on the joint inspection certificate dated August 30, 1935, and, since the charges contained in the repair bill rendered by the F. E. C. are based on actual time and A. A. R. allowances for repairing the damage so covered, the bill should be paid as rendered."—*Case No. 1,761, Clinchfield versus Florida East Coast.*

Multiple Die for Small Steel Car Parts

This article describes a special device used in the punching of small steel car parts. The outstanding feature is that all holes in a part may be punched at one time, yet the high cost associated with conventional die construction is not incurred. The device was originally set up for the production of the parts illustrated in Fig. 1. Its conversion for the production of other parts is rapid and inexpensive.

The device consists essentially of special holders for standard punches and dies, and two base plates, one bolted to the bed of the punching machine and the other to the slide. The holders are made with threaded shanks

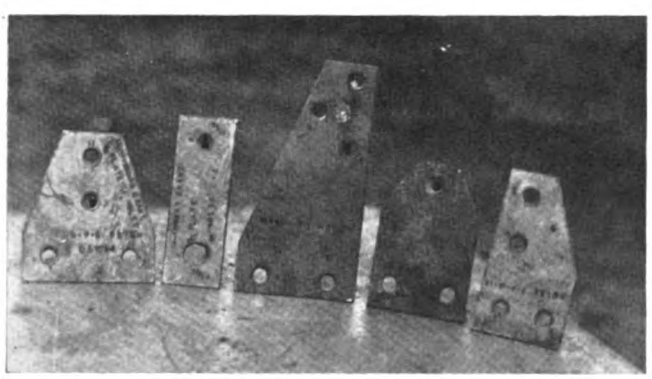


Fig. 1—Plates punched with dies shown in Figs. 2 and 3

so that they may be secured by screwing into appropriately located, tapped holes in the base plates. Both the holders and the base plates are made of ordinary steel; thus, from a material standpoint, they are initially inexpensive. The holders are permanent parts of the equipment and are not discarded unless they are broken or in some other way become damaged. The base plates, on which there is a minimum of machine work, are simple to make and are only replaced at long intervals.

The base plates in this setup were made of steel 2 in.

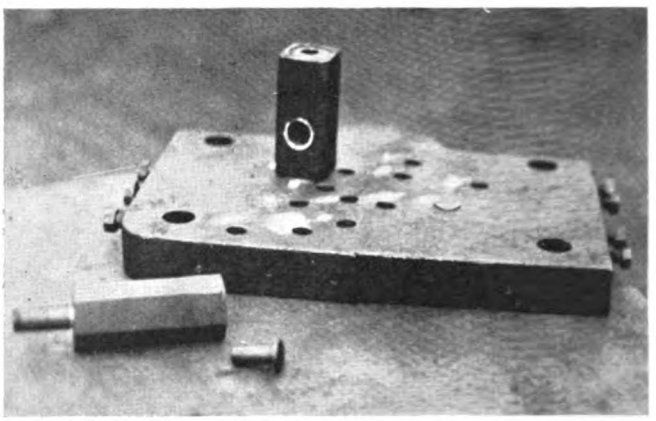


Fig. 2—Base plate which is fastened to the machine bed, with a die holder screwed in position

thick. Holes for securing the punch and die holders are drilled and tapped into these plates in exactly the same arrangement as are the holes in the parts which are to be punched. Figs. 2 and 3, which illustrate these base plates, indicate the many jobs which may be set up on a single set of plates. All of the five parts shown in Fig. 1 are punched by the use of these two bases. As may be noted from Figs. 2 and 3, there is still considerable space available for making setups for other jobs. The limiting conditioning of serviceability is reached when there is no further space available for the locating

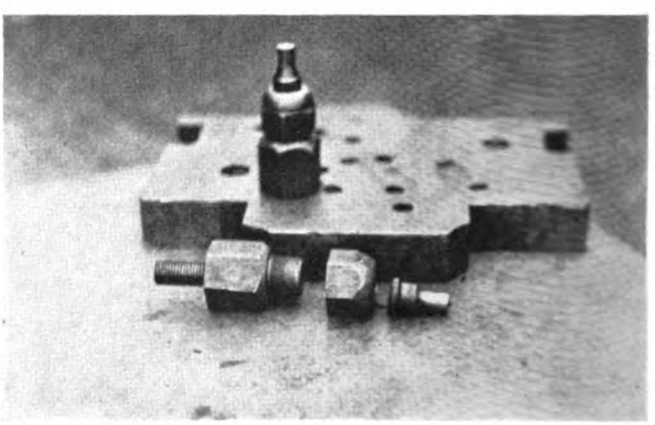


Fig. 3—Punch-holding base plate which is fastened to the machine slide

of additional holes. This time may be extended by the judicious use of one or more holes from a previous setup when laying out for a new job. When using conventional dies it is customary to scrap them after the job is completed, or at best store them for future use. As the only parts disposed of in this device are the two base plates, the saving is immediately apparent.

Fig. 2 shows the base plate which is fastened to the bed of the machine with a die holder screwed into position. Another die holder lying in the foreground shows the threaded shank used for securing the holder to the base plate. The holder is arranged to take a standard die of 1-¾ in. outside diameter, and provides for shedding

the punching slug from a side hole. The hole from which the slug is emitted is outlined in white on the die holder which is screwed to the base plate. A sectional view of the holder is given in Fig. 7. The shank of the holder is 1-⅞ in. long and is threaded with a standard ¾-in. bolt thread. The height of the die holder is governed by the dimensions of the machine to which the

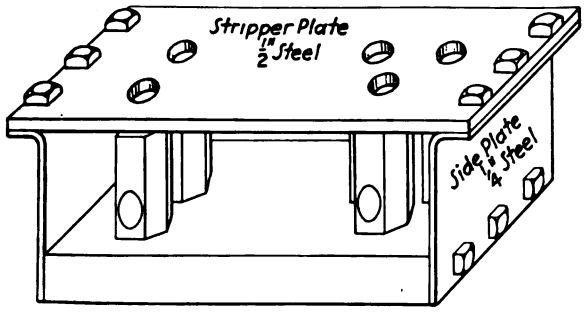


Fig. 4—Stripping arrangement

device is applied. When it is desired to punch square or other noncircular holes, a set-screw is installed near the top of the die holder in such a position as to engage the side of the die. This arrangement prevents the die from turning after it has been correctly located. It has been found advantageous to stencil each hole in the base plate with a number; the template for each part to be punched is then stenciled with numbers corresponding to the holes in the base plates which give the proper die arrangement. While this numbering is not essential, it facilitates rapid setting-up and change-over from one job to another. This arrangement is of particular value when there is a considerable period of time between two runs on the same part.

Fig. 3 shows the punch-holding base plate which is fastened to the slide of the machine. A punch holder is shown screwed into place. In the foreground is a dis-

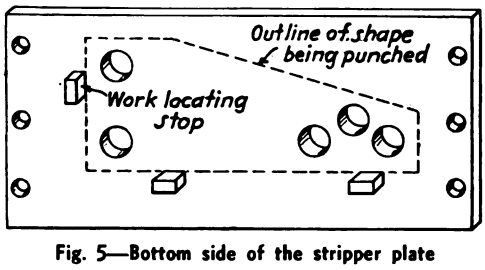


Fig. 5—Bottom side of the stripper plate

assembled holder showing the threaded shank, the nut for securing the punch to the holder, and a standard punch. The shank of the punch holder is made to the same dimensions as that of the die holder. The length of the holder is determined by the dimensions of the machine and the height selected for the die holder. The length is made so that the punch penetrates about ⅛ in. into the die when the machine is at the lowest point of its stroke. In order to distribute the load thrown on the machine by the punching of several holes at one time, it has been found advantageous to use punches of different lengths in a setup.

Several large holes will be noticed in the base plates shown in Figs. 2 and 3. These are used for attaching the plates to the slide and bed of the punching machine. The best procedure in the making of these plates is to clamp them together and drill the holes for the punch and die holders while the plates are thus clamped. This insures exact alignment of the punches and dies without any unnecessary shifting after the plates are mounted.

Several bolts will be noticed on the short sides of the base plate shown in Fig. 2. These are used to attach a stripping device to hold the work down while the punches are withdrawing. Two types of strippers are used depending on the type of work being done. When it is necessary to maintain the edge distance accurately and the production is in large quantities, a stripper is used of the general design shown in Figs. 4 and 5. Locating stops are welded to the bottom surface of the stripper plate. It is generally sufficient to use three such stops for the effective locating of the parts to be punched, as illustrated in Fig. 5. The side plates of the stripping arrangement, shown in Fig. 4, are permanent parts of the equipment. It is only necessary to renew the stripper plate when changing over from one job to another.

When it is not necessary to maintain accurate edge distance, or when the production is comparatively small, a stripper made of ½-in. by 2-in. bar iron, is shown in Fig. 6, is used. Two lengths of this type of stripper are

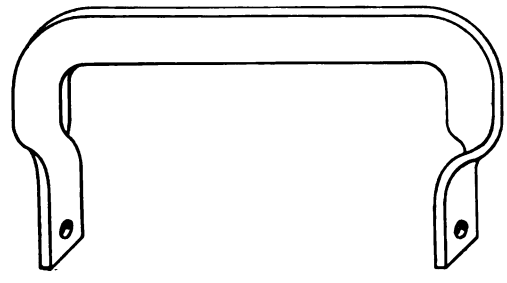


Fig. 6—Alternate stripper design for small runs

provided. The longer ones fit across the base plate from one end to the other in the same general manner as the stripper previously described and shown in Fig. 4. The shorter ones fit across the base plate from back to front. Either type is used, depending upon the job being done. It is sufficient for practically all purposes to use two such strippers. When this type of stripper is used the part

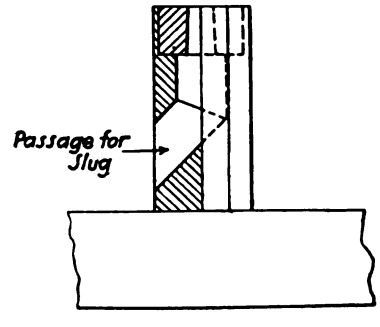


Fig. 7—Section through the die holder

to be punched is located visually, generally with the aid of marks chalked on the stripper.

When punching holes smaller than ¾-in. diameter, there is a possibility of the slug falling into one of the unused die-holder holes in the base plate. Under certain conditions it is difficult to remove these slugs from the holes without taking the base plate off of the machine. Since one of the features of the device is that the base plates need not be removed every time it is desired to change-over from one job to another, plugs of the type shown in the foreground in Fig. 2 are dropped into the unused holes in the base plate; such a plug is also shown in one of the die-holder holes of the base plate. The plugs may be made advantageously by cutting down the head of a ½-in. by 1-½-in. rivet. In set-

ting up the device it is necessary to make certain that the slug-shedding hole in the die holder is not blocked by an adjacent holder. The holder must be in such a position that there is ample space for the slug to fall out.

In the event that such space is not available after setting up, the following procedure is recommended: A washer, made of some light-gage material, is placed around the threaded shank of the die holder so that when the holder is screwed down it will be a portion of a turn back from its position when no washer is present. By the use of one or two such washers it is always possible to locate the die holder appropriately for the shedding of slugs.

This device permits all of the accuracy, speed, and other advantages usually associated with die operation to be obtained, yet does not require the customary large expenditure for regular die construction.

Applying Hand Brakes

At the Dupo, Ill., car repair tracks of the Missouri Pacific, a fairly extensive program of applying modern hand brakes is being carried out and for this purpose the special wood scaffold and template, illustrated, are



Scaffold and template used in laying out bolt holes and applying hand brakes

used to good advantage. This scaffold is 9 ft. 8 in. high and has an 8-ft. top plank 2¼ in. thick by 16 in. wide. The corner posts are 2-in. by 3-in. material, well braced and spaced at the bottom approximately 6 ft. by 12 ft. Suitable ladder rungs on each side give easy access to the top of the scaffold.

Just back of the scaffold and leaning against the car end, is a special template made of light ½-in. by 2-in. wood strips and arranged so it can be used to indicate the accurate positions of all bolt holes used in the application of any particular type of hand brake and brake step. This template not only reduces the time required in laying out the bolt holes but assures their standard correct location.

Questions and Answers On the AB Brake

Brake Cylinders (Continued)

354—*Q.—What should be the approximate time of blow down?* A.—In from 40 to 65 sec.

355—*Q.—With the retaining valve in the low-pressure position, what should be the blow-down rate?* A.—From 40 to 15 lb. in 30 to 55 sec.

356—*Q.—If the blow-down rate were correct in high-pressure position, would it be necessary to repeat the test for the low-pressure position?* A.—No.

357—*Q.—In the event that the valve fails on high-pressure position but is satisfactory in low-pressure position, what may be the trouble?* A.—The trouble would be in the choke between high- and low-pressure positions.

358—*Q.—What is the proper opening for this choke?* A.—A No. 67 drill opening.

359—*Q.—What is the size of the blow-down port in the cap nut?* A.—A No. 54 drill opening.

360—*Q.—What precaution should be taken before making a blow-down test?* A.—All leakage should be reduced to within the limits specified for cylinder, retaining valve and pipe leakage.

361—*Q.—What will cause a blow at the quick-service exhaust in the release position?* A.—Leaking graduating valve, service slide valve, or service portion cover gasket.

362—*Q.—What will cause a blow at the brake-cylinder exhaust port in release position?* A.—Leakage past the service slide valve, service portion gasket, emergency portion gasket, emergency slide valve, or emergency portion cover gasket.

363—*Q.—What will cause a blow at the emergency portion exhaust in release position?* A.—Leakage past the vent valve, the emergency graduating valve, the emergency slide valve or the emergency portion cover gasket.

364—*Q.—What will cause a blow at the quick-service exhaust in the service lap position?* A.—Leakage past the release insuring valve, the service slide valve or the service portion cover gasket.

Compound for Steam Or Vapor Cleaning

The Magnus Chemical Company, Inc., Garwood, N. J., recently placed on the market a product known as "Magnus Vapor Cleaner" which was developed to increase the effectiveness and speed of steam or vapor cleaning by combining the principles of soap washing with solvent cleaning. This combination was made to obtain the two results faster and to effect more thorough "cutting" action than when either is used alone.

This product is offered in two grades: Magnus 92-E for light-duty cleaning and Magnus 94-E for heavy-duty cleaning. Both are light-brown pastes which are soluble in water. They impart to the water a wetting, penetrative and solvent effect said to be superior to that of any soap or alkali. The cleaner is guaranteed to function satisfactorily in any make of steam- or vapor-cleaning machine.

IN THE BACK SHOP AND ENGINEHOUSE

Valves to The Rescue

*By J. H. Gibson**

On March 30, 1938, as the power plant engineer stood, watch in hand, ready to blow the 5 o'clock whistle ending the day's shift in the South Pekin, Ill., enginehouse and yards of the Chicago & North Western, nature decided that the puny efforts of man should be more conclusively terminated.

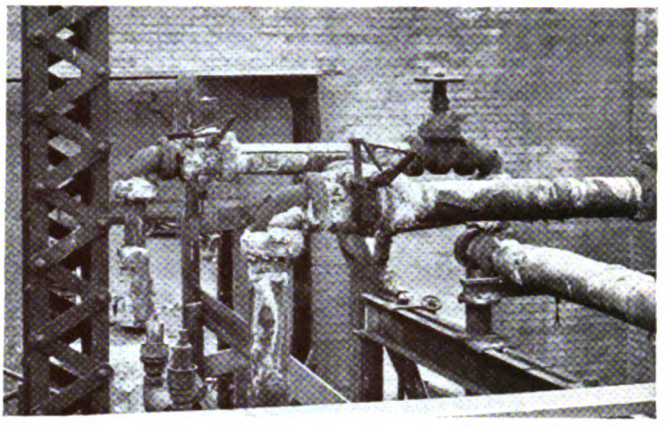
A tornado appeared on the horizon and within approximately 90 seconds swept through this small town of some 800 persons, killing 15, wrecking houses, blowing railroad cars into cornfields, collapsing coal chutes and generally playing havoc.

Among the buildings damaged were the Chicago & North Western enginehouse and power house. This power house was equipped with a 115-ft. high brick stack connected through sheet metal breeching to four 125-hp. horizontal return tubular boilers. The velocity of the wind and the low barometric pressure combined to lift the upper 90 ft. of this stack into the air and drop it on the power house roof where two of the four boilers were under 125 lb. steam pressure.

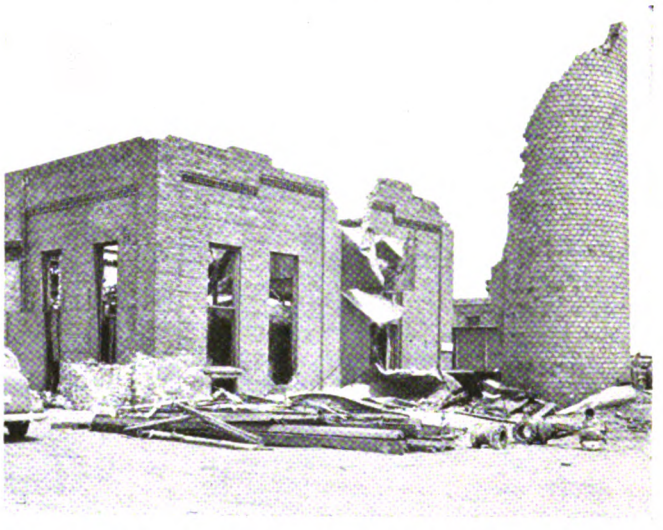
As the steel roof of the boiler room was quite sturdy the weight of this collapsed stack did less damage than would be expected. The boiler settings were not greatly damaged although the main header piping and boiler leads were broken off. Due to the exceptionally high requirements of the Chicago & North Western in matters of safety equipment for employees, passengers and property protection, these boilers had been equipped with Crane-Erwood line protection valves in the boiler leads. These valves were installed in 1912 when the boiler plant was built in an emergency. When the boiler leads from the two working boilers were broken off beyond these valves they immediately closed, due to the high velocity of the escaping steam, protecting the nearby men.



Airplane view of the South Pekin, Ill., enginehouse of the Chicago & North Western after it had been hit by a tornado at 5 p.m., March 30, 1938. Fifteen lives were lost in the town of 800 persons



A close-up view of two Crane-Erwood line protection valves in the boiler leads of the South Pekin, Ill., power plant of the Chicago & North Western enginehouse



The upper 90-ft. of this 115-ft. stack was lifted in the air and dropped on the power house, breaking off the main header piping and boiler leads

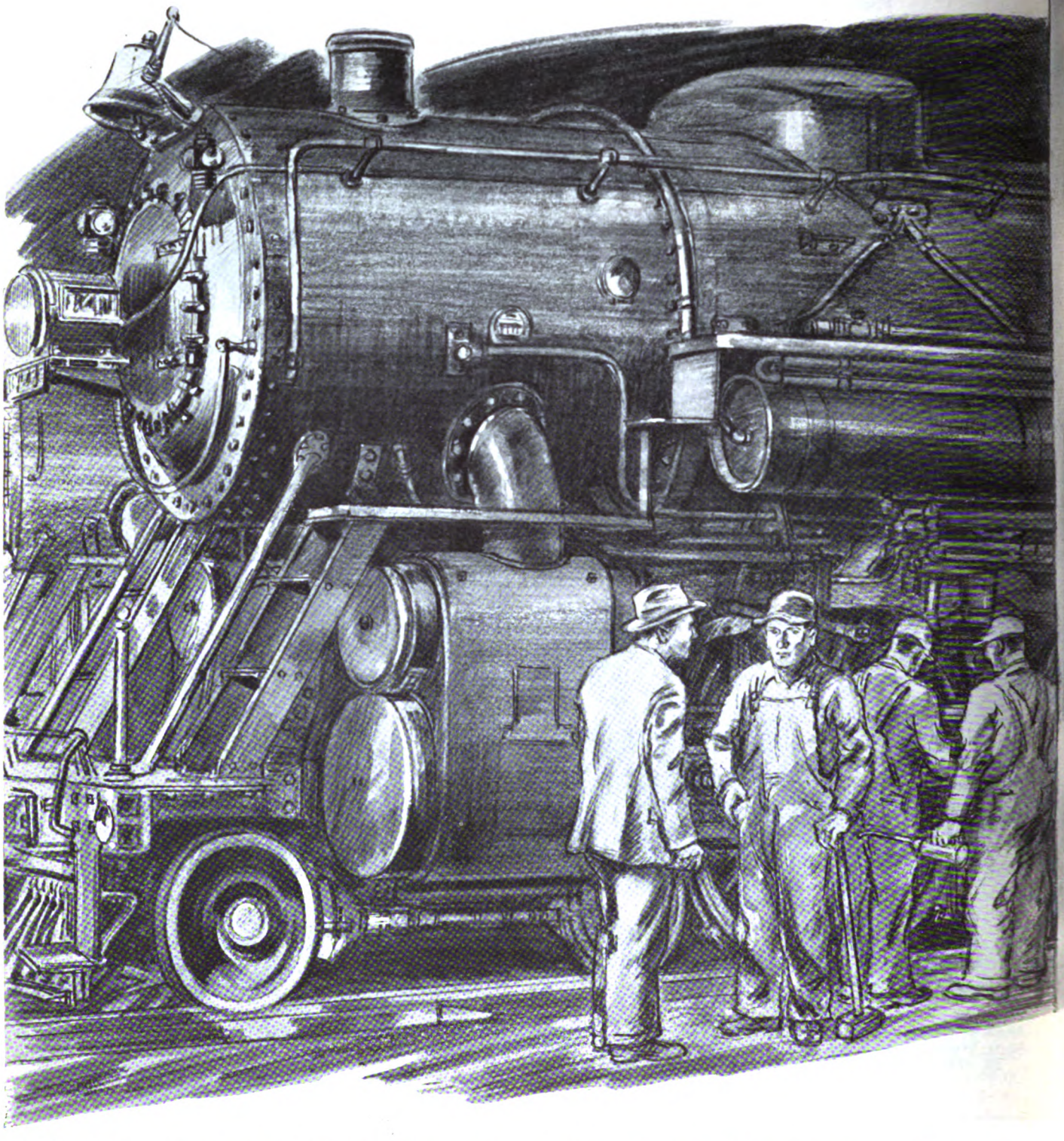
At the approach of the storm William Vogel, who for the past 18 years has been employed by the Chicago & North Western as a car and locomotive painter, had left his own shop and sought protection from the wind and flying debris in the blow-off aisle of the power house. This placed him immediately below the main steam header in such position that had the boilers exploded or the steam from the boilers continued to escape he would doubtless have been badly injured and quite possibly killed.

Division Master Mechanic L. A. Hardin, South Pekin, explains that his maintenance records indicate that these valves had been kept in good working order, along with other equipment in the plant, by a 15-day check-up consisting of proper oiling and testing for free movement

(*Continued on page 491*)

* Railway Sales, Crane Company, Chicago.

It's That Way Now

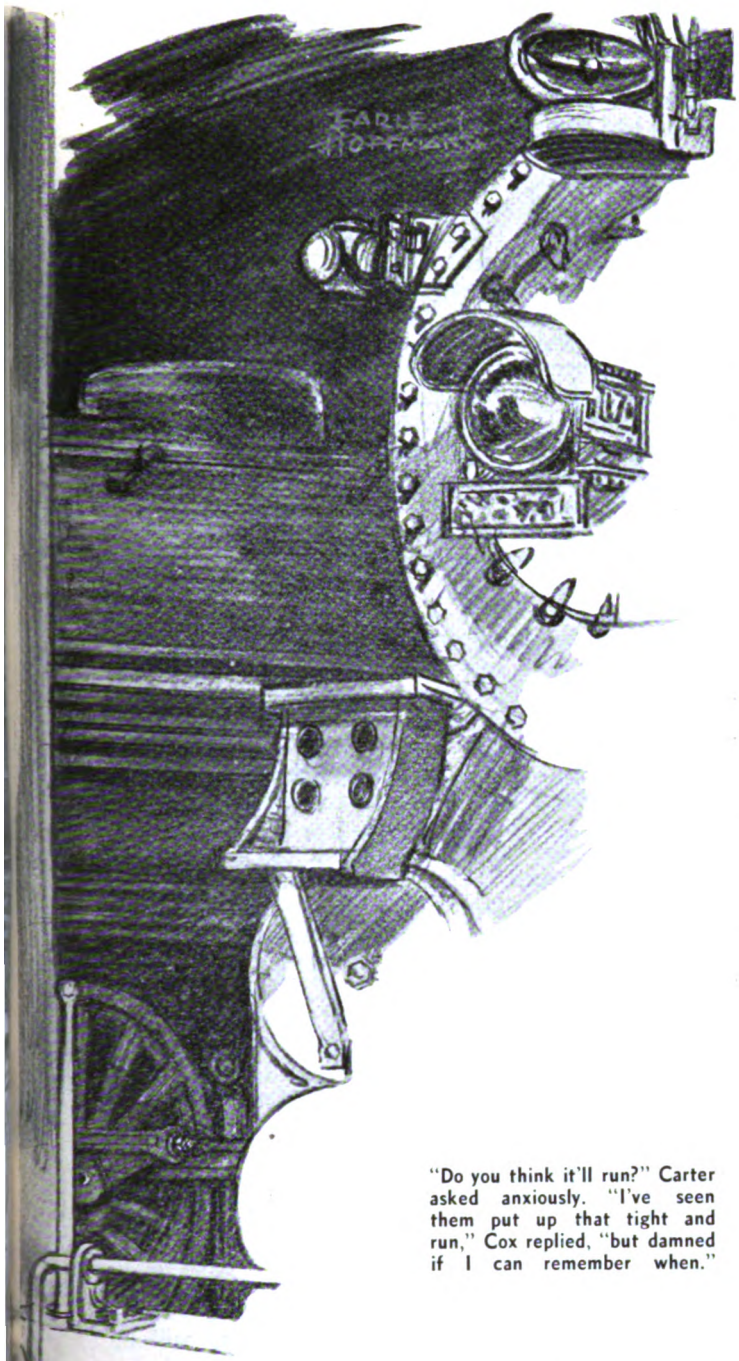


"THE failure was disgraceful," H. H. Carter, master mechanic of the Plains Division, glared at Jim Evans, roundhouse foreman, "disgraceful, I tell you, and the man that put the job up should be taken out of service!"

Evans shifted his hunk of "horseshoe" from one cheek to the other before replying. "Yes, it was bad, but Cox is one of our best machinists and——"

"His record don't show it!" the master mechanic cut in more emphatically than grammatically. "Two investigations in less than two years and now a middle connection bushing he puts up runs hot, ruins the pin and delays a perishable train three hours! Good man—huh! Thirty days to think it over might make him a better man!"

Evans squirmed uncomfortably. He knew that in one sense the master mechanic was right; on the other hand,



"Do you think it'll run?" Carter asked anxiously. "I've seen them put up that tight and run," Cox replied, "but damned if I can remember when."

conditions were such that Evans believed taking the machinist out of service would be an injustice.

"It was partly my fault," Evans said hesitatingly. "Of course, Cox should not have O.K.'d it without knowing it would go, but it was either that or delay the train and work overtime. I might have done the same thing."

"There you go trying to protect Cox," Carter said, "just like you did last time. It was the same way with Harris and Johnson. Are all the men that have engine failures your best mechanics?"

"Just about," Evans replied. "You see, the best men are on the kind of work that might fail. If I didn't put the best men on such work there would be a lot more failures."

"Stuff and nonsense!" the master mechanic exploded. "That's what's the matter with this place now, picking certain men for special jobs! They're all mechanics—they get the rate, don't they?"

"Yes," the foreman replied, "but some are better than others."

by
Walt Wyre

• • •

"Well, it's time you stopped babying them. Put them on jobs as you come to 'em and send the ones that can't do the work back to the farm where they belong! See that you do it, too!" Carter reached for a letter indicating that the conversation was over.

Evans hesitated a moment then turned and left the office. He knew there was no use trying to argue the question at the moment. The foreman was at least satisfied that he would not be forced to pull Cox out of service. As he walked back to the roundhouse, Evans mentally reviewed the failure.

It was on the 5086. She was scheduled to go over the drop pit for classified repairs. The hostler ran the engine in the house and she wasn't blown down because she was to be run over the pit as soon as the 5088 came off. He was going to use a 2700 on the reefer train, but the dispatcher called at 4:00 and said to use a 5000, they were picking up eight cars of cattle and a 2700 wouldn't handle it. The train was called for 5:20 and there wasn't any other 5000.

Evans told Cox to look the engine over and repair what was absolutely necessary. The right middle connection bushing might have run, if a Federal inspector didn't see it, then again it might not. Cox decided it should be renewed and went at it. That would have been O.K. if the lathe man had made the bushing to fit the greatest diameter of the pin which was out of round and tapering.

The bushing started O.K., went about half way, then stuck. "Bump it a couple of licks," Cox told his helper.

The helper hit the bushing three or four blows with a piece of 4 x 4 oak. It moved about an inch and got tighter. "Pretty tight," the helper said.

"Yeah." The machinist tried to pull the brass out. It wouldn't budge.

At that moment Evans came by. "How you coming?" the foreman asked.

"O.K.," Cox replied. "This bushing is a little tight, but I think it will go."

The foreman moved on. The bushing did too, with the assistance of an eight-pound sledge.

When the bushing was in place, Cox looked at it and scratched his head. "I've seen them put up that tight and not run hot, but damned if I can remember when!"

"About ready to go?" It was the hostler come to take the engine out of the house.

"Just a couple of minutes," Cox said. Then to his helper, "Give her plenty of grease and hope it runs."

It didn't; hence the conference between the foreman and master mechanic.

Next morning following the pow-wow in the office, the master mechanic was in the roundhouse before eight o'clock. Evans was at the board sorting work slips.

"Remember what I told you yesterday about the work," the master mechanic reminded.

"I'm starting now," Evans replied as he began to rearrange the work slips.

When the eight o'clock whistle blew the men ganged around the desk at the board unaware of the surprises in store for them.

Machinist Jenkins from past experience expected his first slip to read "line down wedges." In the past eight years, most of Jenkins' work had been lining driving box wedges. It's a job that requires no great amount of skill or mechanical ability and Jenkins can qualify on both counts.

He was as surprised as a Republican at being appointed postmaster when he read the slip. "Examine valves, both blowing badly." The engine was the 5071 marked up to be run at 10:15 p. m. on the Limited.

Brown, another hammer and chisel machinist, had been getting by on superheater units, tank trucks and such work. He can get dirtier, make more noise and do less work than any other machinist in the roundhouse at Plainville. Some imp of perversity must have nudged Evans' elbow when he placed a slip reading "engine very lame, square valves" in Brown's box.

When the machinist read the slip, he had the appearance of a man that wished for an elephant—and got it.

Reed, Johnson, and Cox are real machinists that take pride in their work. Circumstances sometimes forced them to take chances and sometimes they lost. But when a job put up by either of the three turned out badly, it was always a crushing blow to their pride. The jobs assigned to them that morning didn't do their pride any good.

Reed drew a set of superheater units, Johnson got a miscellaneous assortment of lining down driving-box wedges, changing a pair of tank wheels and such, while Cox was assigned to taking out draw-bars on a couple of engines due for a three-month test.

After the jobs were assigned, Evans went to the office, looked in his locker to see if he had any aspirin tablets and sat down to look over the mail.

Looking over the mail was about all, for his mind was not on it. His thoughts were in the roundhouse and of what was happening there. He had done just what he had wanted to do ever since he had been foreman and he knew it wouldn't work out. Theoretically, all mechanics of a craft are equal; practically, there's a lot of difference, and any foreman that fails to recognize and take advantage of that fact is likely to hub a streak of hard luck.

The good men get the particular jobs and suffer the consequence, that's what they get for being good men; while the hammer and chisel artists fall heir to work that is nearly fool proof.

EVANS couldn't stand the strain of sitting and wondering very long. He took a fresh chew of "horseshoe" and headed for the roundhouse.

As the foreman was walking by the 5079 he heard a flow of profanity that would have put a Missouri mule skinner to taking lessons in the art of swearing. Evans leaned over and peered between the locomotive drivers. Machinist Johnson and his helper were down in the pit and Johnson was really down. When the foreman looked, the nut-splitter was just raising up.

"What's the matter, Johnson?" Evans asked. "Having trouble?"

When Evans spoke the machinist involuntarily jerked his head to look up. When he did his head struck a spring hanger. That invoked another stream of profanity.

"Dammit," Johnson said, "I stepped on a gob of grease and fell. Then," he added, "I bumped my head. If I've got to do this kind of work, I wish they'd keep grease out of the pits!"

"I thought I heard you say just a few days ago that you were getting tired of boring cylinders," Evans reminded. "You said then you wished you could get on a job where there wasn't any responsibility."

"Yeah," Johnson replied. "I might have said it, but I was just bellyaching—didn't mean anything."

The foreman went on down to stall number five where Brown was running over the valves on the 5076. The machinist had figures all over the right cylinder casing and was beginning on the left.

"How you coming?" Evans asked.

"O.K., I guess," Brown replied hesitatingly. "It's been some time since I had any experience with a Walschaert valve gear," Brown added.

"Didn't you say not very long ago that you could square a set of valves as well as Harris or anybody else?" Evans asked.

"I meant when I'm in practice," the machinist replied, "but I'll get her O. K."

"If you don't," Evans said, " I don't want to hear you complaining any more about superheater units."

"Oh, I don't mind superheater units," Brown replied promptly.

The foreman smiled as he turned to walk away. At least some good was being accomplished by the shuffle of mechanics.

Near the lineup board, Evans met the master mechanic. "How are things going?" the master mechanic inquired.

"Oh, about as usual, I guess," the foreman replied. "I've got the men switched around as you suggested."

"How is it working?"

"Can't tell yet," Evans replied. Then another idea struck him. "But I wish I had waited until some other time."

"Why some other time?" the master mechanic asked.

"Oh, nothing much." The foreman turned as though going to walk away.

"Well, tell me why now is not as good time as any," the official insisted.

"Oh, I had some business uptown," Evans told him, "and now I can't get away. It doesn't matter."

"Go ahead," Carter said. "It's not so many years since I ran a roundhouse."

"You mean you'll run the roundhouse until I get back?"

"Why not? Don't you think I can?"

"Certainly, but——"

"Go ahead," the master mechanic cut in. "I'll take care of things."

"Thanks." Evans started to the office wearing a grin that almost pierced each ear. "I'll be back late this evening."

"Never mind," Carter said. "in the morning will be soon enough."

WHEN the foreman had left, Carter went on through the roundhouse stopping at each locomotive to look it over. He was standing in front of the 5090 watching and listening while machinist Reed wrestled with a set of superheater units.

Reed, usually careful of his appearance, had put on a freshly laundered suit of overalls that morning but no one would have guessed it. The machinist had gotten wet and soot was caked on the blue denim in heavy layers. An almost new pair of tan shoes would never be tan again. His eyes, glittering from suppressed anger, shone from a soot blackened face. He didn't like it, that was evident, but he was working with a will.

The master mechanic watched a while and walked on.

Carter's next stop was at the engine where Jenkins was pulling the valves on the 5071. Profanity seemed the order of the day for Jenkins was swearing too. Not loud, but fervent.

Every move the machinist made seemed to be the

wrong one. Tools were scattered all around, lying on the pilot and every place near. Some had fallen in the pit. The right valve was out ready for inspection. The machinist was working on the left.

"Well, how you making out?" the master mechanic asked.

"Not worth a damn!" The machinist, intent on his work, had not noticed who he was talking to. "I haven't got the right tools for this work." Then Jenkins looked up. His face turned red as a new main line caboose. "I'll have this one out in a little bit."

Carter examined the right valve bull ring and bushings. "This one is cut pretty bad," he said. "It'll need new bushings."

While Carter was examining the valve bushing, John Harris, the roundhouse clerk, came up. "The dispatcher wants two 5000s for extras east," the clerk said. "I gave him the 5068 for the first one. Evans said it was O.K. What shall I give him for the second?"

"I'll let you know in a few minutes." Carter headed through the house at a brisk walk stopping in front of every 5000 to look at the work report. Not a one of them could be made ready to run in a reasonable time. Carter decided to use the one that came in on the first run on the second. It was to run one hour later.

Just before noon, the master mechanic acting foreman went to see how Brown was getting along with squaring the valves of the 5076. It was marked up to run at 2:15.

Brown had made changes at every place changes could be made. Somehow every change for the worse. He was running the valves over for the twentieth time when Carter came up. His helper was at the throttle running the engine.

"About to get her?" Carter asked.

"Well, I don't know," the machinist replied doubtfully. "I'm a little rusty."

"Let me look at it." Carter signalled the helper to back the engine.

The master mechanic ran the valves and scratched his head. According to his calculations, only a slight change would be needed to eliminate reverse entirely. The twelve o'clock whistle caught the men wondering what to do next. Carter, somewhat out of practice was further befuddled by what the machinist had done.

"Haven't we got a machinist here that is in practice on valves?" the master mechanic asked testily.

"Yes, Reed is."

"Where is he?"

"Down on the 5090 pulling some superheater units," Brown said, "or was; I guess he's gone to check out now."

"Well, catch him and tell him to work noon hour," Carter said. "And if you know anything about taking out superheater units, get on the 5090 at 1:00."

"Yes, sir," the machinist replied. "I've pulled more units than any man here."

THE 5097 came in on the first extra east in good condition except the left main pin was stinking hot. Carter had figured to work it on the lead and not run the engine in the house. One look at the hot pin told him it would be inviting a failure with possibly a lot of damage to run the engine.

"Get it in the house soon as you can," Carter told the hostler.

The dispatcher agreed to set the call up on the second train forty-five minutes which was some respite.

Jenkins was waiting for valve bushings from the machine shop at the time. The master mechanic had told him to work the 5090.

The hostler got the engine in the house in record time and Jenkins went to work taking the rods down. The machinist, more nervous by the official's presence, was all thumbs. He picked up the wrong wrench, dropped it, and picked up another that didn't fit.

Carter got nervous too. At the rate Jenkins was starting, the pin wouldn't be ready to caliper in an hour. Then the master mechanic remembered what Evans had said about Cox. "Go get Cox to help on this job," he told Jenkins' helper.

Jenkins did the helping while Cox did most of the work. The lathe man was waiting, calipers in hand. He already had a brass in his lathe and the first cut taken.

The machine man turned out the bushing in short order. A little more time would have made a better fit. It was plenty tight, but a few raps with a sledge drove the bushing home.

"Do you think it'll run?" Carter asked anxiously.

"I've seen them put up that tight and run," Cox replied, "but damned if I can remember when. Give her plenty of grease and it might run."

When the job was finished Cox went back to his drawbars and Jenkins returned to his valves. The bushings were ready for the left side and he started pressing them in.

The front bushing was tight but it went with a lot of persuasion. The master mechanic watched it pressed in. Then he examined the bushing. His face turned purple. He tried to speak but only succeeded in sputtering.

Jenkins looked and his face turned purple too. The bushing was turned so that ports didn't line up.

After an hour trying to pull the bushing, Carter told the machinist to have the bushing cut out. He then went in search of machinist Cox. "Say, can you put in valve bushings?"

"I have," Cox replied.

"Well, go down to the 5071 and tell Jenkins to finish with these draw-bars. And," he added, "stay with the 5071 until you get it done."

Evans returned just before five o'clock. He walked through the house and to the desk. "How did things go?" he asked the master mechanic.

"Not so hot," Carter replied gruffly. "I had to change the men around a little to get any work done. They've been on one thing so long they can't do anything else."

And Evans knew enough to keep his mouth shut. It was a day well spent and he had enjoyed sitting around home a few hours.

Valves to The Rescue

(Continued from page 487)

as well as being opened approximately once a year, examined and repacked. On one occasion some time ago new stems had been installed, otherwise no repairs had been made in the 26 years these valves had been in service.

The accompanying illustrations indicate the extensive damage as well as the general layout of the boilers and piping. Forethought by the railway engineers who designed this plant, coupled with the quality of safety devices, doubtless in this case not only saved a life but minimized capital investment loss as well.

The National Safety Council's safety award for 1937, signifying the council's highest recognition for Class A railways, was awarded to the Chicago & North Western May 16, 1938. In the last eight years the North Western has led this group five times and been runner-up

the other three times. The presentation was made by D. D. Fennell, chairman of the Award committee, with Fred W. Sargent, president of the North Western, accepting it in behalf of the railway company. President Sargent paid tribute to his employees and to employees of other railroads who have striven to improve their safety ratings. The Class A group includes 19 railroads, these which have registered 50,000,000 or more man-hours of work during the year. In addition to the Class A contestants there were 146 other railroads in the competition.

Incipient Axle Cracks Located Electrically

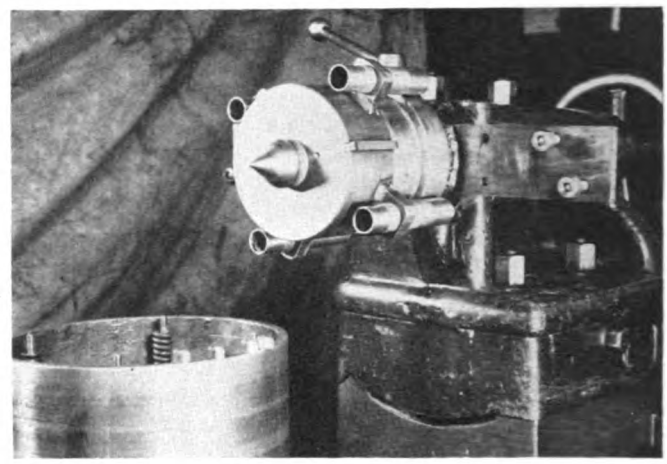
Over a period of years, railroads have been subject to derailments because of fatigue failures in axles, which usually occur in the wheel seat, approximately ½ in. in from the edge of the wheel. Axles can be tested satisfactorily only when wheels have been removed. A new method, perfected by the Sperry Products, Inc., Hoboken, N. J., locates cracks not visible to the eye or under a magnifying glass. In this method, a heavy alternating current is passed through and concentrated at the surface of the axle as it is rotated in a lathe; any cracks in the axle will cause changes in the voltage gradient along sections of the axle. These voltage changes are automatically recorded on paper, thus making a permanent record of the condition of the axle in regard to cracks; therefore, potential seats of failure are obtained without depending upon either the technique or the watchfulness of the operator.

The testing eqiupment is designed for installation in standard lathes, and can be handled conveniently in any regular shop. It consists of current heads, brush carriers, a transformer, a searching unit, an amplifier and a recorder.

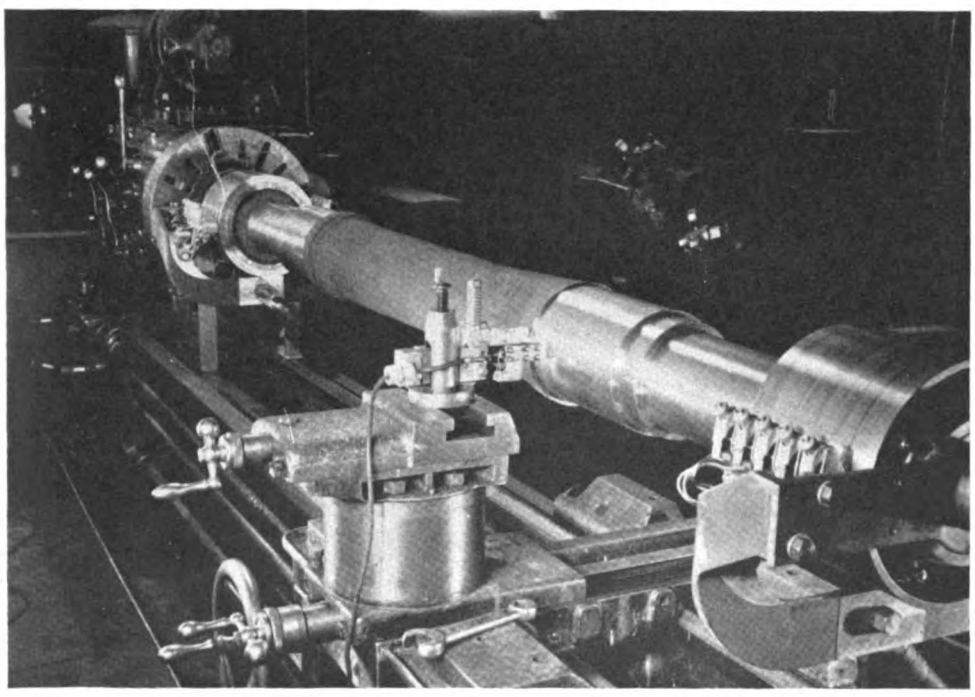
The current heads are designed to operate continuously with a testing current of 1,000 amp. and have ample brushes designed to maintain low temperatures. The brushes operate on cast-bronze slip rings provided with copper-mesh contact pads which insure uniform current distribution through the ends of the axle. The axle ends are cleaned to secure sufficient testing current. The journal and wheel seats must also be cleaned to secure good searching-unit contact.

The searching unit consists of two accurately positioned contact members made of a special alloy and designed to allow maximum rotary testing speeds. These members are spaced longitudinally on the axle to measure continuously variations in the voltage gradient resulting from changes in conductivity caused by flaws at or near the surface of the axle. By means of spacing, selecting and design of the contact members, operating speeds ranging from 16 to 40 r.p.m. are practicable.

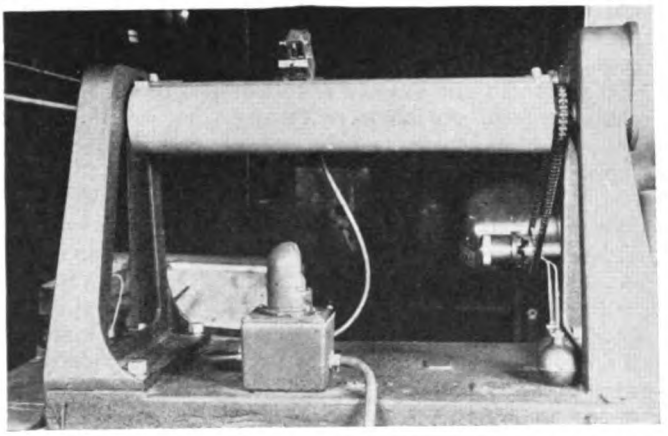
The recorder comprises a rotary drum driven synchronously with the axle relay, which functions whenever the voltage at the searching unit rises above a predetermined value. Normally, the paper chart, wrapped on the rotary drum, shows one spiral inspection of the axle per 1/16 in. of chart. The chart record removed from the drum constitutes a diagram of the surfaces tested, showing defective regions where the voltage was higher than the calibrated value. The recorder is fitted with a Neon lamp visible to the operator during testing; this lamp is



The tailstock current-head carrier unit before application of the contact pad and slip-ring casting shown in the left-hand corner



Sperry axle-testing equipment—A current is passed through the axle and a searching unit mounted in the tool post picks up any change in voltage gradient induced by cracks — Voltage changes are recorded on charts



The recording element used with the Sperry electric axle-testing equipment

in series with the record pen, and provides a means for visual testing if records are not required.

The amplifier equipment consists of a high-gain voltage amplifier and a low-gain power amplifier operating into a galvanometer relay to actuate the indicating and recording apparatus. Both amplifiers utilize standard types of radio tubes. The equipment includes meters for maintaining operating level, means for calibrating the amplifier system, and means for adjusting the detection range.

The transformer used with the apparatus has a capacity of approximately 32 k.v.a., intermittent, at 50-60 cycles, which is sufficient to provide working results. The transformer will supply 4, 5, 6, 7 or 8 volts by primary tap connections to provide flexibility in setup.

Setting up the current heads in the lathe involves no difficulty. To accommodate the headstock current head, a chuck is applied to the lathe headstock spindle, the chuck being of sufficient size to take a 3¼-in. stub shaft on the current head. An extension shaft, screwed to the stub shaft, provides direct recorder drive.

The headstock current-head assembly is lifted into the lathe, the recorder drive shaft being passed through the headstock spindle while the stub shaft is clamped in the chuck; the jaws of the chuck are centered so that the center runs true within 0.010 in.

A simple jaw clutch is then assembled on the end of the recorder drive shaft; this enables the recorder drum to be turned, for purposes of record inspection or for initial-position adjustment relative to the axle, independent of the lathe. The recorder is set up adjacent to the lathe and driven by a roller chain running over a clutch sprocket.

Installation of the tailstock current-head assembly includes a carrier unit rotating on ball bearings, which accommodates the contact pad and slip-ring casting. The tailstock spindle is run out, after removing the center, until it projects about 6 in.; the carrier unit is then mounted thereon in a manner which leaves it free to rotate on its ball bearings. The tailstock end of the lathe thus becomes equipped with a live center which permits the slip ring and contact pad to rotate freely with the axle under the end thrust applied to maintain current.

The searching unit is set up in the tool post of the lathe with its contact points lying on a diameter of the axle wheel seat. The searching unit is completely insulated from the tool post and is connected by a two-wire cable plug to the amplifier at a central control cabinet.

The amplifier equipment, located in the cabinet, is operated as a constant-gain device with the complete system voltage-regulated, so that changes of plus or minus 10 per cent in line voltage or strong voltage surges at large defects produce negligible change in testing sensitivity.

During operation, the sensitivity of the detecting unit is set as desired so that only changes of a predetermined magnitude will be recorded. The set can thus be used to find flaws without interference or confusion which might be caused by surface irregularities.

The operating level (average input voltage) varies very slightly on a uniform axle section. Changes in cross section are adjusted for by the operator in routine order. Testing of straight sections requires no adjustment up to the point of tangency at fillets; the operator can, if necessary, examine the important part of a fillet by careful adjustment of the gain control at this region.

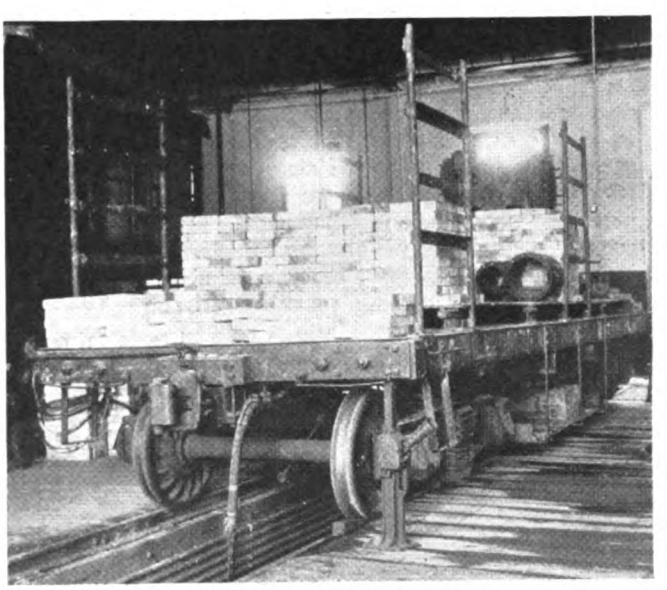
Such testing should result in further service life for axles, which are arbitrarily condemned after a given period of service; each axle can be disposed of according to the test results.

Cylinder Welding Car

The welding of locomotive cylinders on the erecting floor, in addition to requiring floor space not conveniently available at all times for the construction of furnaces, also creates more or less fire hazard because of wood floors. The welding car, illustrated, is used at the Northern Pacific shops, Brainerd, Minn., proving quite satisfactory in this service. Its use avoids crowding of the erecting floor, eliminates fire hazard and permits welding to be done under most favorable conditions.

Kept in the enginehouse adjacent to the erecting shop, the welding car is moved to the erecting floor where cylinders to be welded are loaded on the car by an overhead crane. The car is then returned to the enginehouse where cylinders are prepared for welding. Furnaces are built around the cylinders which are pre-heated with a coke fire. After welding, the cylinders are allowed to cool slowly before the furnaces are dismantled, and the car is moved back to the erecting floor for unloading the welded cylinders.

This car was constructed using the underframe from a dismantled Lidgerwood car on which are placed sheets



Cylinder welding car used in welding dismounted cylinders outside of the erecting shop

of 1-in. boiler plate supported by pieces of rail to prevent transmitting of any great amount of heat from furnaces to car. Steel supports on the sides of the car are for erection of a scaffolding used by welders and may be moved to suit the position on the car of the cylinder to be welded. Car jacks, shown under the side of the car are used to prevent the car rocking and dislodging the brickwork of the furnaces.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

The Manufacture of Charcoal-Iron Boiler Tubes

Q.—How are charcoal-iron boiler tubes manufactured?—J. S.

A.—The following method of manufacturing charcoal iron tubes, used by the largest manufacturers of charcoal iron tubes, consists of four processes, each of which is a separate operation in its particular mill. These processes are (1) the manufacture of the charcoal-iron blooms from the raw materials by the knobbling process, (2) the reduction of the iron blooms into bars, (3) the rolling of the bars into skelp, and (4) welding the skelp into tubes.

The raw material is charged into the hearth of the knobbling forge along with charcoal. A cold air blast is applied and the metal is slowly fused. The metal is worked until it matures, that is, until globules of iron form. During the working, the action of the charcoal rids the iron of impurities, leaving a lump of commercially pure charcoal iron. The lump, as it comes from the forge fire, is a rough, porous mass made up of globules of charcoal iron, each covered by a thin coating of slag or cinder.

Immediately after the lump has been formed at the forge, it is removed and placed under a shingling hammer and hammered into a bloom of the required size. In this operation the globules of iron are welded together, the thin coating of slag or cinder remaining between the particles of pure iron, and thus producing planes of separation which protect the iron against corrosion, pitting, and the action of acids. The cinder coating has a very important bearing upon the physical properties of charcoal iron.

The bloom is charged into a coal-fired reverberatory heating furnace, slowly brought up to a welding heat, and then rolled on a bar mill into a charcoal-iron bar. The heating and rolling operation has a refining action upon the iron. The globules that existed in the original lump attain an elongated, fibrous structure. Each subsequent heating and rolling further refines the iron.

The bars are cut in lengths of 2 or 3 ft., placed one above the other, and wired together in a pile of sufficient size and weight to produce skelp of a specified width and thickness to make a certain size tube. The pile is charged into a reverberatory heating furnace chamber which is separate from the coal chamber, thus preventing the iron from absorbing impurities from the coal. Here the iron is allowed to attain a welding heat.

The heated pile of bars is rolled on a roughing mill to about ¼ in. thickness. During the several passes through the roughing rolls, the bars are thoroughly welded together, an extra thick layer of protecting slag occurring between the bars. The strip of skelp is then passed through planishing and finishing rolls, where it is brought to required thickness and the edges scarfed.

From the scarfing rolls the strip of skelp is conveyed to the shears, cut to proper tube lengths, and while still hot is drawn through dies which form it in a tubular shape, with the scarfed edges overlapping, ready for welding.

The formed tube is charged cold into a gas-fired furnace, and upon reaching welding heat is pushed up to the welding rolls, with the lap up. The tube passes through the rolls over a mandril and is thoroughly welded. Charcoal iron welds easily, but to assure a perfect weld, the tube is first set aside to cool, after which the heating and welding processes are repeated. The tube is run through the sizing rolls to reduce it to proper size and then through the cross or hot straightening rolls. After cooling, the tube is run through a cold straightener, thus assuring a straight tube.

Plugging of Superheater Tubes Below the Arch

Q.—On engines having two syphons we put the arch down to the tube sheet and carry it seven bricks high. These engines have a tendency to plug the two top superheater tubes, one on each side of the syphons; in other words, we clean these tubes when we wash out the engine and in one trip they will come in with the four superheater tubes plugged. Other engines of the same class without syphons will go a whole month without the tubes becoming plugged.

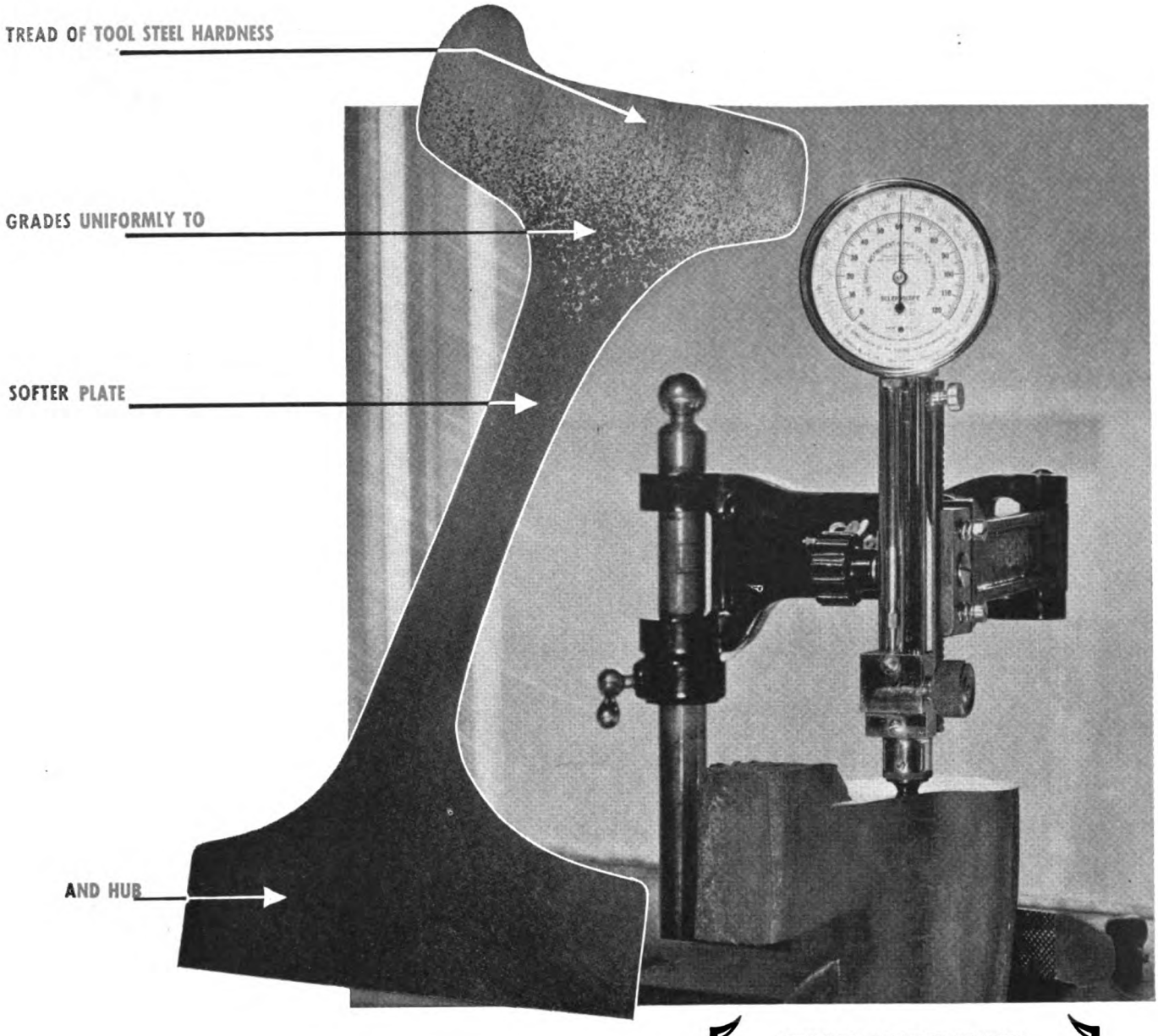
I have thought that such plugging occurs because of the small clearance between the crown and side sheets and the syphons, and because, with the Standard stoker firing fine coal, the coal would be fired with a sharper force on each side of the syphon. We have to dig these tubes out with an iron bar for about 1 ft. before we can blow them out.—B. C. H.

A.—The information given in the question is insufficient to determine the cause of the trouble experienced. It is apparent that for some reason there is insufficient draft through the tubes in question or that these particular tubes are being required to pass more cinders than they can handle. It is possible that the front of the syphons are located too close to the firebox tube sheet, and, with the use of a stoker, the fine cinders are being diverted by the syphons; thus, the amount of the cinders going through the tubes, which are in line with the sides of the syphons, is materially increased, especially at the top due to the action of the crown sheet in also diverting the cinders, causing these particular tubes to become plugged.

The question of proper arch would also have considerable effect upon the plugging of the tubes and should be checked.

The fire arch in modern locomotives should be of sufficient length so that the gas opening between the back end of the arch and crown sheet, or the gas opening between the back end of the arch and the fire door sheet, does not fall below the total gas area through the tubes and flues; preferably, the opening above the arch should be 115 per cent of the tube and flue area. The same proportion should exist between the back end of the arch and the door sheet.

(Turn to next left-hand page)



THE SECRET of CHILLED CAR WHEEL MILEAGE

Wearing qualities and strength of chilled car wheels are definitely related to character and depth of chill. The A.M.C.C.W. Research Laboratory has developed instrumental determination of these factors, and the Inspection Service provides the means of making this control effective.

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High Spots in

Railway Affairs . . .

Labor Will Co-operate

Generally speaking, and aside from some of the things that George Harrison, chairman of the Railway Labor Executives Association, said in the heat of the recent wage controversy, he is regarded as pretty well balanced and more or less of a statesman in the union labor field. In commenting at the recent Triennial International Transportation Conference of the Y. M. C. A. of North America, at Toronto, on remedial measures which should be adopted by the government in dealing with the railroads, he made the following statement: "Along with that I think there is a splendid opportunity for labor to make its contribution not only directly by influencing policies that will permit transportation to develop and grow, but by bringing to the public a better understanding of the problems of the industry and the necessity for fair treatment to that great agency so essential to the development and growth of the country."

Recommends Federal Department of Transportation

Chairman of the Interstate Commerce Commission W. M. W. Splawn, in an address before the National Association of Railroad and Utility Commissioners in New Orleans, recommended that a Department of Transportation be created by the federal government that would be an executive department in which could be lodged all of the promotional and other activities now carried on by eight or ten different departments and authorities. The Interstate Commerce Commission would be relieved of many of its present activities and would exercise jurisdiction, under federal statutes, over rates and fares and the prevention of discriminations in rates and fares.

Fiddling While Rome Burns

Under the leadership of Senator Burton K. Wheeler, chairman of the Senate Committee on Interstate Commerce and Railroad Finance, constructive measures for the relief of the railroads were carefully avoided last year and lengthy hearings were devoted to digging into railroad financial practices. What will the Senate do in the next Congress? While other agencies interested in transportation are suggesting practical and constructive measures for strengthening the railroads, Senator Wheeler announced at the Fourteenth New England Conference that he had prepared two bills for presentation to Congress. One of these proposes to make it easier for railroads not in trusteeship or receivership to borrow money for renewals and repairs, giving them the privilege of granting a prior lien for new money borrowed for such purposes. Another bill provides standards for railroad reorganizations. These may be all very well, but what are the Senator and his committee going to do to put through other measures which will relieve the railroads of some of the unfair handicaps under which they are now operating?

President's Committee-of-Six

Blocked in all directions in the effort to save themselves from financial disaster, the railroads have now only one way in which to turn, and that is to the Administration and Congress for remedial legislation. Among the many agencies which are giving consideration to this problem is the so-called President's Committee-of-Six —three representatives of railroad management and three from the railroad labor unions (October issue, page 397). This committee, appointed by President Roosevelt, promptly resumed its activities after the wage controversy settlement and met in Washington on November 7. It is understood that the day was spent in discussing the situation and that each member will individually prepare recommendations for later consideration by the committee as a whole. The labor members of the committee are George M. Harrison, chairman of the Railway Labor Executives' Association; D. B. Robertson, president of the Brotherhood of Locomotive Firemen and Enginemen, and B. M. Jewell, president of the Railway Employees Department, American Federation of Labor. The representatives of management are Carl R. Gray, vice-chairman of the Union Pacific; M. W. Clement, president of the Pennsylvania, and E. E. Norris, president of the Southern.

Shippers Also Worried

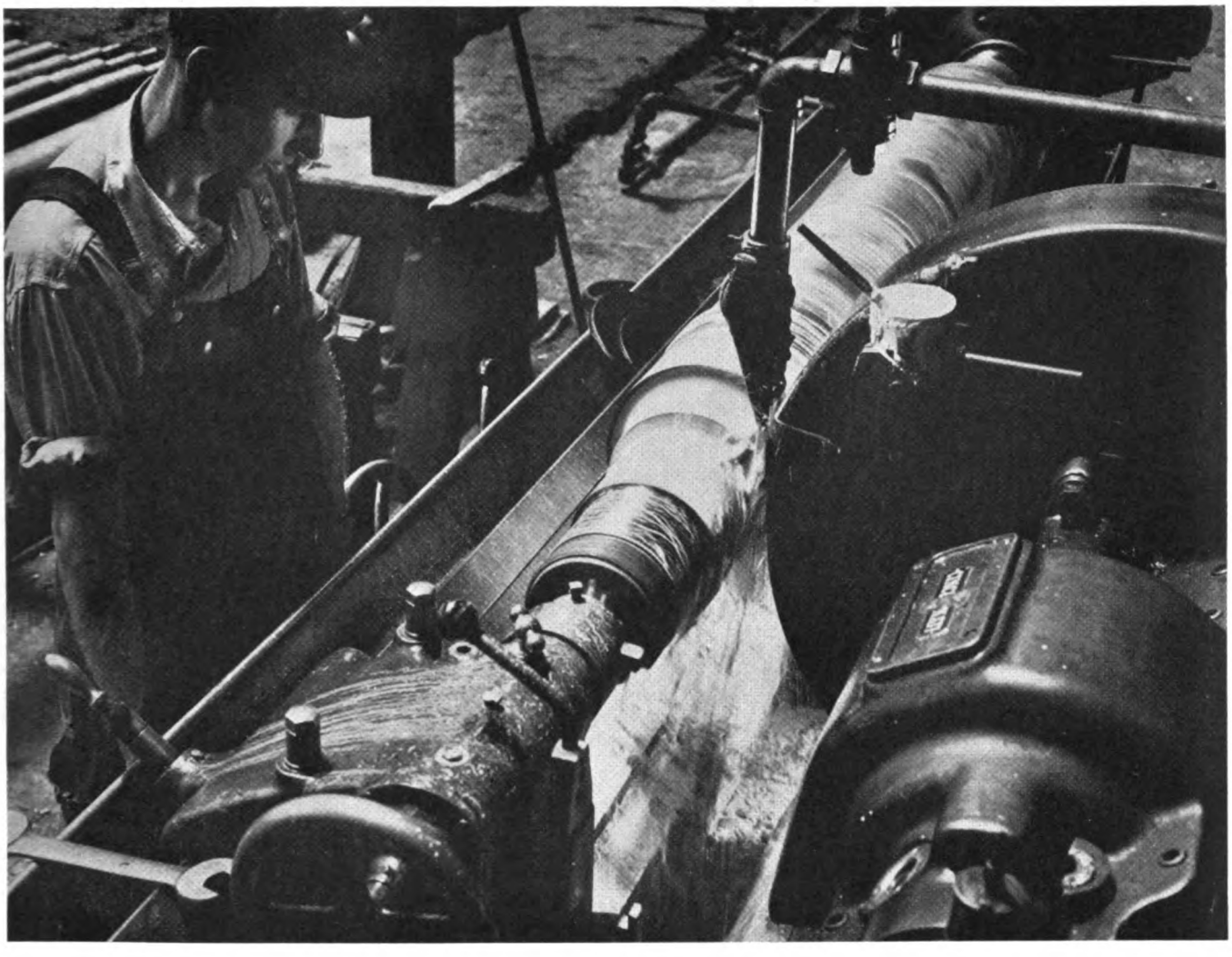
Even the shippers, as represented by the National Industrial Traffic League, are greatly concerned over the precarious condition in which the railroads find themselves. At a meeting of the League, recently held in New York City, certain parts of the railroad legislative program suggested by the Association of American Railroads were approved. These include loans to the railroads; repeal of land-grant statutes; withdrawal of the government from the Federal Barge Line as soon as a buyer can be found; tax relief measures; credit for railroad unemployment insurance taxes to the extent of employee dismissal allowance actually paid; amendment of the Clayton Act and amendment of the laws authorizing the appearance of government officers in rate cases. The league either opposed or took no action on the other recommendations. It did appoint a special committee on the railroad situation, however, which was given rather broad powers, in order that it might act effectively during the legislative crises of the next few months. This committee was characterized by the officers of the League as comprising the most influential members of that organization.

Railroad Transport Clinic

The Transportation Conference sponsored by the U. S. Chamber of Commerce was mentioned in the High Spots of our October number. It held a second meeting during the latter part of November and adopted a number of resolutions suggesting lines along which relief should be granted to the railroads. Among these were resolutions suggesting means for facilitating reorganizations; the repeal of the land-grant statutes; relief of expense in excess of net direct benefits for elimination of railroad grade crossings, and the reconstruction of railroad bridges in connection with navigation or flood control projects; relief from the undistributed profits tax; the avoidance of such restrictive measures as the train length limit bill, excess crew laws, six-hour day legislation, etc.; that Congress should require the government to dispose of the Federal Barge Line to private parties; and that the Railroad Labor Act should be amended (a) to include public members in odd numbers on adjustment boards so as to insure disposition of each case in the first instance; (b) to authorize federal court review of adjustment board decisions at the instance of the railroads, as now allowed employees; and (c) to place a limit upon the time within which claims can be presented. Resolutions were also passed with recommendations to facilitate consolidations, to speed up the disposition of abandonment applications, etc.

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METHODS AND MACHINERY THAT GUARD LIMA QUALITY



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On modern grinders Lima brings to a perfect finish the axles and shafts whose proper fit plays an important part in low maintenance. » » » Throughout every operation in the building of modern power close tolerances and accurate fitting is of greatest importance. » » » Lima, possessed of both the equipment and the experience, has earned an enviable reputation for turning out well-built locomotives.

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Among the Clubs and Associations

Mechanical Division Convention

THE General Committee of the Mechanical Division, A. A. R., at a meeting in New York on Wednesday, November 16, decided to hold a three-day convention in New York next year. The exact dates will depend upon arrangements which can be made for convention facilities, but the meeting will probably be held late in June. The transportation exhibits at the World's Fair will take the place of the exhibit which is ordinarily associated with conventions of this organization.

Railroad Engineers Get A. S. M. E. Awards

DURING the annual meeting of the American Society of Mechanical Engineers, held at New York during the week beginning December 5, two railroad men received honors and awards. Lawford H. Fry, railway engineer, Edgewater Steel Company, Pittsburgh, Pa., received the Worcester Reed Warner Medal, bestowed for an outstanding contribution to permanent engineering literature, for his "written contributions relating to improved locomotive design and utilization of better materials in railway equipment." A. I. Lipetz, chief consulting engineer in charge of research, American Locomotive Company, Schenectady, N. Y., was presented with the Melville Medal for 1938 for his paper on "The Air Resistance of Railroad Equipment."

A. S. M. E. Railroad Division

CHAS. T. RIPLEY, chief engineer, Technical Board of the Wrought Steel Wheel Industry, Chicago, is slated to head the Railroad Division, American Society of Mechanical Engineers, during the coming year. Mr. Ripley succeeds Prof. Edw. C. Schmidt, head, Department of Railway Engineering, University of Illinois, Urbana, Ill., who retired as chairman of the Division at its annual dinner and business meeting which was held on December 8, 1938, at the Midston House, corner of Thirty-eighth street and Madison avenue, New York City.

J. R. Jackson, engineer of tests, Missouri Pacific, St. Louis, Mo., was nominated by letter ballot to fill the vacancy on the Executive Committee, Railroad Division, created by the retirement of Professor Schmidt. Mr. Ripley and Mr. Jackson were recommended to the president of the society and appointed by him.

The following were elected to serve on the General Committee of the Division, terms to expire in December, 1943: F. G. Lister, superintendent of motive power, St. Louis-San Francisco, Springfield, Mo.; Prof. G. A. Young, head, School of Mechanical Engineering, Purdue University, Lafayette, Ind., and John Roberts, chief of motive power and car equipment, Canadian National, Montreal, Que.

John G. Adair, mechanical engineer, Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C., was elected to the General Committee to fill the vacancy caused by the death of the late Harvey Boltwood. Mr. Adair's term expires in 1939.

Harold C. Wilcox, associate editor, *Railway Mechanical Engineer,* New York, was elected to fill the vacancy created by the promotion of Mr. Jackson to the Executive Committee. Mr. Wilcox's term will expire in December, 1940.

St. Louis Car Men Honor K. F. Nystrom

A BRONZE plaque containing the inscription "For His Outstanding Contribution to the Science and Art of Design and Maintenance of Railroad Rolling Stock" was presented to K. F. Nystrom, mechanical assistant to vice-president, Chicago, Milwaukee, St. Paul & Pacific, by the Car Department Association of St. Louis at a meeting held Tuesday evening, November 15, at the Hotel Mayfair, St. Louis, Mo. The presentation was made following an address by Mr. Nystrom on "Master Car Builders" before about 280 members and guests of the association, including a group of car-department officers from Chicago.

In discussing his subject, Mr. Nystrom said that the master car builder or car department supervisor must be a competent director, teacher, employer and builder of men. He said that car supervisors must accept whether they like it or not the responsibility for the safety, reliability and maintenance of rolling stock and that with this great responsibility goes the proportionate privilege of insisting upon acquiring the best equipment science and good workmanship can produce.

As regards the future, Mr. Nystrom said, "I am convinced that at no time in railroad history was there such great opportunity for improvement and advancement as at present. During the period of depressions since 1929, considerable changes have been made in practices and railroad operation. We are doing things today which, ten years ago, we would have said could not be done. We have eliminated

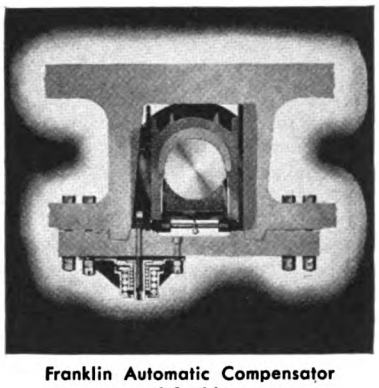
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A DRIVING BOX *takes a pounding too*

Locomotive driving boxes can "Take It", but the incessant pounding that results from an improperly adjusted wedge will soon have the locomotive in the shop for repairs . . . reduce such repairs by eliminating the cause with the application of Franklin Automatic Compensators and Snubbers.



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repair tracks and inspection points, and reduced forces in greater proportion than traffic has been reduced, and at the same time, we have a better operation. At present, we have fewer hot boxes, fewer equipment failures and fewer accidents than we had ten years ago. This is an achievement in which we can take some comfort, but there are many problems which we must solve, as the speed of our trains is constantly increasing, and we have not yet reached the limit. Therefore, when anything goes wrong with the railroad machine, the damage is far more costly than in former days." Among other items which present the possibility and need for still further improvement, Mr. Nystrom mentioned trucks, brake rigging, couplers and draft gears and box car interiors designed so that they can be kept at all times "as sanitary as a modern warehouse."

"Lumber Night" at N. Y. Railroad Club

FOUR short talks and a full-length sound motion picture described the ins-and-outs of the lumber industry in general and the interdependence of that industry with the railroads in particular in a program presented by the Weyerhaeuser Sales Company of St. Paul, Minn., before 600 members and guests of the New York Railroad Club on October 28. Opening the program, F. K. Weyerhaeuser, president, Weyerhaeuser Sales Company, outlined the extent to which lumber is used in American industry and building and reviewed its production curve. He pointed out that the industry stands fourth in the number of employees and fifth in wages paid in the country and that more than 6,000,000 people depend upon it for a livelihood. He especially emphasized the fact that lumber is the only readily reproducible national resource and stated that with a modern and entirely practical schedule of reforestation and protection American forests will produce two or three times the number of trees for which markets are now available.

M. W. Williamson, manager, railroad and car lumber sales, spoke on the modernization of the lumber industry, reviewing the progressive mechanization of the processes of harvesting trees and handling them at mills. "What the Railroads Mean to the Lumber Industry" was the subject presented by I. N. Tate, vice-president and secretary of the company. In illustration of the interdependence between these two industries, the speaker cited the following railroad activities which have or had an effect on lumbering: (1) Land grant tracts given to the railroads became a tremendous source of supply for timber and the desire of the roads to secure working capital from their holdings of timber acted as a great stimulant for the sale of their lumber interests and hence to the development of the industry and the opening up of the West. (2) The willingness of the railroads to build branch lines into inaccessible timber areas widened the area of lumber operations. (3) The Transportation of products from saw mills to large markets performed by the railroads is absolutely essential, for lumber is a bulk commodity and is produced a great distance from its chief markets. For example, the rail haul of fir timber to eastern territory averages 2,600 miles. (4) Experience has further proven that they [the railroads] deliver the products of the lumber industry in better condition than is possible in any other medium of transportation. The Weyerhaeuser mills were able to increase the percentage of their all rail shipments from 61 per cent in 1934 to 69½ per cent in 1937. (5) The railroads have been large users of forest products, averaging about 20 per cent of the total products in pre-depression years to less than 10 per cent at present.

In discussing the volume of lumber shipped by rail, Mr. Tate declared that the lumber industry wants to ship its products by rail but is finding it increasingly difficult to do so. In illustration of this he pointed out that ten years ago certain eastern distributing yards shipped 77 per cent of their lumber by rail. This volume shrank to 17¼ per cent in 1936, to 9½ per cent in 1937 and to 5½ per cent in the first eight months of 1938. Furthermore, he said the industry in the South and West is finding it increasingly difficult to hold to rail shipment to nearby points. In conclusion the speaker said that great opportunities exist for railroad traffic in lowering transportation costs so as to make available to markets certain species and types of trees that are at present left in the woods because of unprofitability.

The final speaker, H. T. Kendall, vice-president and general manager, in discussing what the lumber industry means to the railroads, pointed out that over 7 per cent of total carloadings are lumber; that the average freight on lumber is $269 per thousand dollars of value, compared with $62 to $82 on iron and steel and $79 on stone.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION. — R. P. Ives, Westinghouse Air Brake Company, 3400 Empire State building, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION. — J. F. Gettrust, P. O. Box 5522, Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—C. E. Davies, 29 West Thirty-ninth street, New York. Annual meeting December 5-9, Engineering Societies building, New York.

RAILROAD DIVISION.—Marion B. Richardson, P. O. Box 205, Livingston, N. J.

MACHINE SHOP PRACTICE DIVISION.—J. R. Weaver, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

MATERIALS HANDLING DIVISION. — F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

OIL AND GAS POWER DIVISION. — M. J. Reed, 2 West Forty-fifth street, New York.

FUELS DIVISION.—A. R. Mumford, N. Y. Steam Corp., 130 E. Fifteenth st., New York.

ASSOCIATION OF AMERICAN RAILROADS. — J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

OPERATING SECTION. — J. C. Caviston, 30 Vesey street, New York.

MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

PURCHASES AND STORES DIVISION.—W. J. Farrell, 30 Vesey street, New York.

MOTOR TRANSPORT DIVISION. — George M. Campbell, Transportation Building, Washington, D. C.

CANADIAN RAILWAY CLUB. — C. R. Crook, 4468 Oxford avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS. — J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, Hotel Mayfair, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p. m.

CENTRAL RAILWAY CLUB OF BUFFALO. — Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION. — E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, second Friday of each month, except May, June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION. — R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION. — See Railway Fuel and Traveling Engineers' Association.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—F. T. James (President), general foreman, D. L. & W., Kingsland, N. J.

INTERNATIONAL RAILWAY MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

MASTER BOILER MAKERS' ASSOCIATION. — A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB. — W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September, at Hotel Touraine, Boston.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July, August, September, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION. — F. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, University and Prior avenue, St. Paul.

PACIFIC RAILWAY CLUB. — William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Calif., alternately, excepting June in Los Angeles and October in Sacramento.

RAILWAY CLUB OF GREENVILLE.—Sterle H. Nottingham, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FIRE PROTECTION ASSOCIATION.—P. A. Bissell, 40 Broad street, Boston, Mass.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, 1255 Old Colony building, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION. —J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

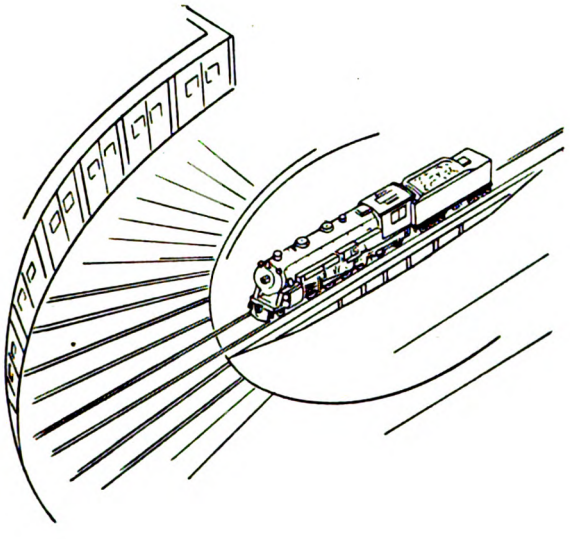
TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

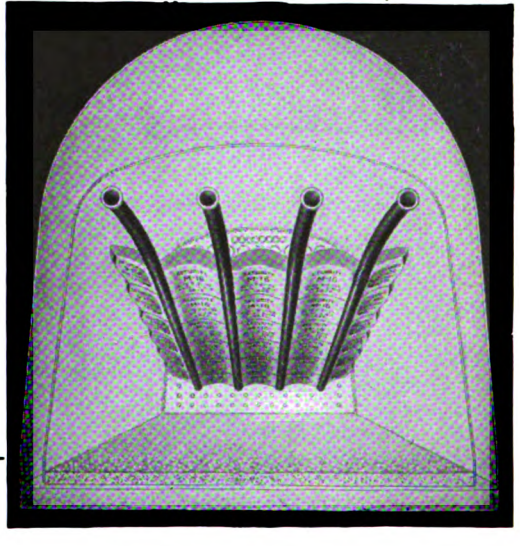
TRAVELING ENGINEERS' ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

WESTERN RAILWAY CLUB.—W. L. Fox, executive secretary, Room 822, 310 South Michigan avenue, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

(Turn to next left-hand page)

BE SURE
No Arch Brick
Is Missing





There's More to SECURITY ARCHES *Than Just Brick*

In these days of rigid economy, don't draw the line too fine and let a locomotive leave the roundhouse with an imperfect Arch due to lack of supplies.

A single missing Arch Brick has a mighty serious effect on steaming and on the efficiency of the locomotive.

Today, a dollar's worth of fuel means more than ever before. To spend it effectively, every Locomotive Arch should be maintained in perfect condition.

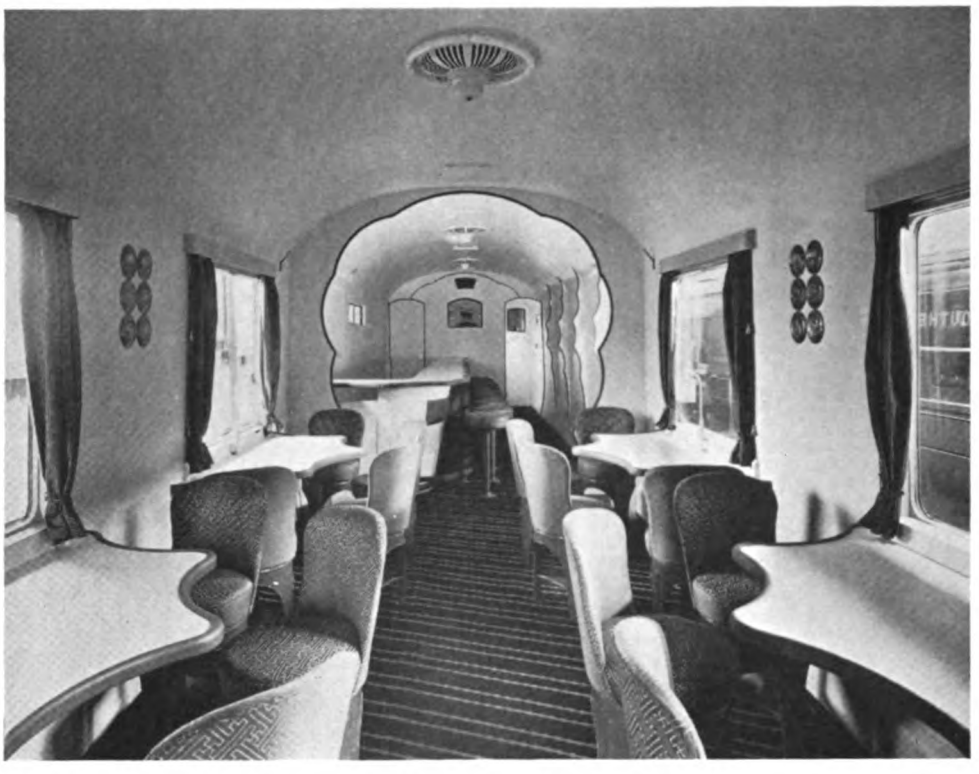
Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency will not suffer.

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.
Locomotive Combustion Specialists



A buffet car for use on the electrified lines of the Southern Railway of England

NEWS

New Construction

THE Chicago & Eastern Illinois has awarded a contract to The Austin Company, Cleveland, Ohio, for the construction of the Oaklawn shops at Danville, Ill., a new coach shop 110 ft. by 417 ft. of brick construction with steel framework on a concrete foundation. The project will cost approximately $200,000.

Dismantling Program

THE Chicago, Rock Island & Pacific has under way a program for the dismantling of freight cars and locomotives which is being accomplished at the rate of 200 cars or more per month. During September, 295 freight cars and 4 locomotives were dismantled; during October, 448 freight cars and 18 locomotives; and during November, approximately 200 freight cars and 17 locomotives.

Equipment Building in Railroad Shops

The Missouri Pacific has completed the construction of 100 50-ton 45-ft. flat cars at its DeSoto, Mo., shops.

The Illinois Central is constructing 100 flat cars 52 ft. long and 10 ft. 4 in. wide in its shops at Centralia, Ill. The under-frames have been fabricated at the Nonconnah shops at Memphis, Tenn. Not including parts of 100 flat cars of smaller sizes that will be dismantled and used, the work will cost approximately $145,000.

1938 Mechanical Division Letter Ballot Results

IN Circular No. DV-940, issued under date of November 8, by the Association of American Railroads, Mechanical division, the results of the letter ballots on commendations of various committees reporting to the meeting of the General Committee at Chicago on June 29, 1938, are given in detail, a total of 78 individual propositions being involved. As a result of a favorable letter ballot all of these propositions to amend the standard and recommended practice of the division are approved effective March 1, 1939; with the exception of Propositions 4 (a) to 4 (aa), inclusive, covering definitions and designating letters which are approved effective immediately; and with the further exception of Propositions 9 to 55, inclusive, to amend the loading rules of the division which are approved effective February 1, 1939.

Roads Withdraw Wage Reduction

THE railroads have withdrawn their demand for a 15 per cent reduction in wages. By this action, taken at the annual meeting of the Association of American Railroads at Chicago on November 4, the railways will comply with the recommendation of the President's fact-finding committee.

The meeting at Chicago was called in response to President Roosevelt's request on October 31 for early advice regarding the attitude of the railway managements towards the findings of the emergency board. In a telegram sent to President Roosevelt in the afternoon, announcing the withdrawal of notices of wage reductions, J. J. Pelley, president of the Association of American Railroads, said in part:

"The railroads are taking this action, not because they agree with the conclusions reached by the board, but because they recognize the gravity of the situation, and because they hope that out of it there will come, through the co-operation of all concerned, a sounder and more equitable transportation policy in this country."

I. C. C. Expands Authorization For Use of Welded Tank Car

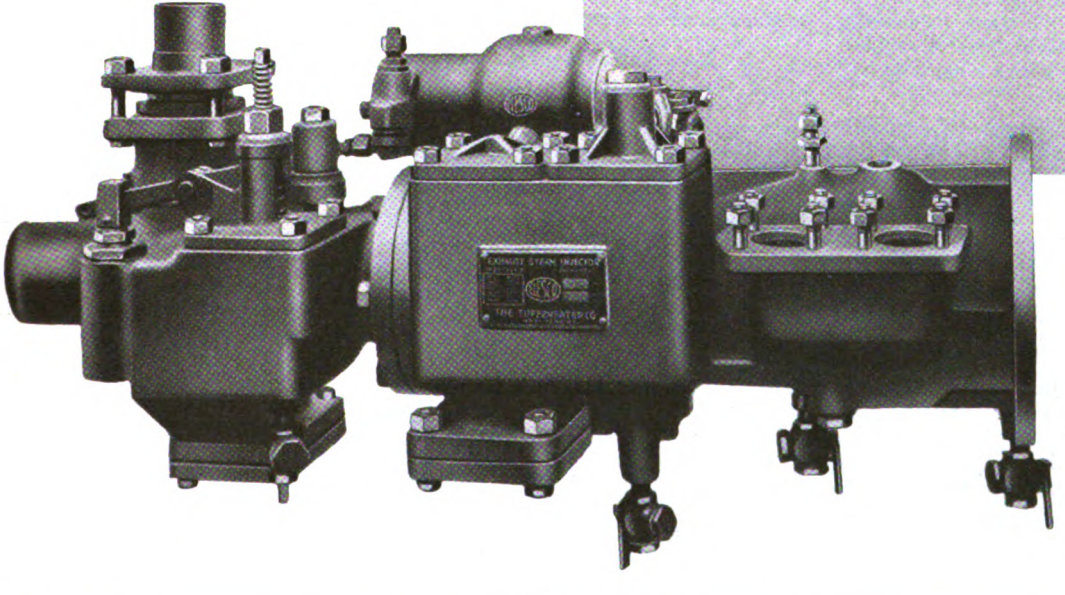
THE Interstate Commerce Commission, by Commissioner McManamy, has authorized the trial use of a glass-lined, two-unit, fusion-welded tank car for the transportation of water-white, electrolyte-grade (66 deg. Baume) sulphuric acid. The

(*Continued on next left-hand page*)

ELESCO EXHAUST STEAM INJECTORS

. . . Provide
the Highest
Heat Recovery
Per Unit of Weight
and Per Dollar Invested

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authority, carried in an order amending the order in No. 3666, Special Series A, dated September 4, 1935, does not involve the construction of the car; it merely expands the authorization as to the use of a car already built.

Bureau of Safety Accident Report

Of the total of 95 accidents reported by the Bureau of Safety, Interstate Commerce Commission for the period July, 1937, to July, 1938, 21 were attributed either wholly or in part, to roadway influences; 7 were laid to rail or switch failures, 4 to structure faults, 7 to landslides, rockslides or washouts and 3 to miscellaneous obstructions on track. Failures in rolling stock were cited as the cause of 9 accidents, and the contributing cause of 1 mishap. Such mechanical factors included 2 coupler failures, 3 truck and side clearance irregularities, 2 arch-bar truck breakdowns and 1 broken journal due to overheating.

Streamliners Make Money, Says Report

Reviewing in varying degrees of completeness the operation of some 76 high-speed "luxury" trains which have been introduced on American railroads in the last four years, Coverdale & Colpitts, consulting engineers, New York, conclude that "Every lightweight streamlined train operating in this country has produced additional passenger traffic and substantial earnings for the railroad placing it in service." In the 68-page report on "Streamline, Light - Weight, High - Speed Passenger Trains," which Coverdale & Colpits have prepared for the Edward G. Budd Manufacturing Company, Philadelphia, Pa., there are contained short histories of each train selected for treatment, classified by operating roads, details of the trains themselves, characteristics of their present routes, speed statistics, and, where obtainable, revenue and traffic figures.

The Denver "Zephyrs," of the Chicago, Burlington & Quincy, produced the highest ratio of earnings of any train of this type in the year ended June 30, 1938, the report shows. Building up a gross revenue of $2,088,938, these trains earned a net of $1,568,831, or 75.1 per cent of the gross and $2.07 per train-mile. Highest net revnues per train-mile were earned by the two "Daylights" of the Southern Pacific, operating between Los Angeles, Cal., and San Francisco, and the two "Hiawathas" of the Chicago, Milwaukee, St. Paul & Pacific, the report reveals, the former rolling up $3.211 per train-mile and the latter $3.217. In August, 1937, during the summer vacation season, the "Daylight" trains took in fares aggregating $6.28 per train mile. Of the long distance sleeping-car trains, the "City of San Francisco," operated by the Chicago & North Western, Union Pacific and Southern Pacific between Chicago and San Francisco, shows the highest net per train-mile—$2.529.

Chicago-Denver, Colo., runs appear to be the leaders in daily mileage. Each of the two "City of Denver" trains of the North Western-Union Pacific run 1,048 miles each day, while each of the Burlington's Denver "Zephyrs" cover 1,036 miles daily. The record for average speed seems to be held as well by the Denver "Zephyrs" for their 66 m.p.h. average speed on scheduled runs (one of these trains made a non-stop run of 1,017 miles from Chicago to Denver in 12 hours 12 min., at the average speed of 83.4 m.p.h. on October 23, 1936).

The Atchison, Topeka & Santa Fe, now possessing the largest fleet of streamline trains, actually had only one of these, the "Super Chief," in operation before the beginning of 1938, but these trains still produced $1,306,928 in gross revenue, with a net earning of $1.27 per mile. The ratio of net earnings to the gross was 61.3 per cent.

Of 28,395 passengers carried by the "Pioneer," "Twin," "Sam Houston" and "Ozark State" Zephyrs of the Burlington, 6,187, or 21.8 of the total, answered periodical questionnaires to the effect that they would have traveled by auto, bus or plane had not the Zephyr service been available. These and similar statistics not included on the report "prove conclusively that the new trains have induced a large number of persons to travel by rail who would not otherwise have done so."

The report pointed particularly to the growth of traffic on the Santa Fe's "Super Chief." The first new lightweight "Super Chief" was placed in service between Chicago and Los Angeles in May, 1937. In February, 1938, a second train was added to provide twice-a-week service. Revenue for the period January 1 to June 30, 1937, was $238,581; from July 1 to December 31, 1937, it grew to $306,286, and for January 1 to June 30, 1938, to $488,072.

In the report attention is called to the fact that the data are based wholly on records compiled by the accounting staffs of the respective railroads and that the information given therein, therefore, is authoritative. The items, however, are not entirely comparable one railroad with another. Overhead charges not directly apportionable to train operation—interest, depreciation, taxes and insurance—are omitted from the statements of revenues and expenses, also terminal rentals.

Representation of Shop Employees

Great Northern.—Some Great Northern shop employee groups voted for representation by organizations operating through the Railway Employees Department, American Federation of Labor, while others chose the Associated Organizations of Shop Craft Employees, Great Northern Railway, in recent elections conducted under the auspices of the National Mediation Board.

In one election covering the road generally the A. F. of L. unions were chosen by the machinists, blacksmiths, molders, electrical workers, the apprentices and helpers of the foregoing, and power house employees and shop laborers; Associated won the right to represent the boilermakers, sheet metal workers, and carmen (including coach cleaners), their apprentices and helpers. In a separate election held among employees of King Street station, Seattle, Wash., the Associated was chosen by the machinists, sheet metal workers (including molders), electrical workers, and carmen (including coach cleaners), and the apprentices and helpers of the foregoing; A. F. of L. unions won among the power house employees and shop laborers, while in the craft of blacksmiths, their apprentices and helpers no certification was made for the reason that

New Equipment Orders and Inquiries Announced Since the Closing of the November Issue

Locomotive Orders

Company	No. of Locos.	Type of Loco.	Builder
Kansas City Terminal	1	900-hp. Diesel-electric	American Loco. Co.
	2	Diesel-electric switch	Electro-Motive
Seaboard Air Line	1‡	Diesel-electric	Electro-Motive
Sorocabana Railway	4*	4-10-2	American Loco. Co.
White Pass & Yukon Route	1†	2-8-2	Baldwin Loco. Wks.

Locomotive Inquiries

Columbus & Greenville	5	2-8-2	.....
Reading-Central of New Jersey	15§	Diesel-electric	.....

Freight-Car Orders

Road	No. of Cars	Type of Car	Builder
Cornwall Railroad	20	75-ton ore cars	Bethlehem Steel Co.
Bessemer & Lake Erie	100	Flat	American Car & Fdry. Co.
Illinois Central	1,000	Box	American Car & Fdry. Co

Freight-Car Inquiries

Norfolk & Western	1,500	55-ton hopper	.....
	600	50-ton box	.....
Wheeling & Lake Erie	400	60-ton hopper	.....

Passenger-Car Orders

Road	No. of Cars	Type of Car	Builder
Seaboard Air Line	1‡	Dining	Edw. G. Budd Mfg. Co.
	6‡	Chair	Edw. G. Budd Mfg. Co.
Southern	25	70-ft. express¶	Bethlehem Steel Co.

Passenger-Car Inquiries

Temiskaming & Northern Ontario	1	Rail motor car	.....

* Meter-gage, three-cylinder 4-10-2 locomotives.
† Total engine weight about 72½ tons; 17-in. by 22-in. cylinders; driving wheels, 44 in. in diameter.
‡ The locomotive and seven cars will comprise one train of stainless steel streamlined.
‡ The locomotive will be equipped with two 1,000 hp. General Motors Diesel engines.
§ Purchase authorized.
¶ Subject to the approval of the I. C. C.

no organization or individual received a majority vote.

Virginian.—Labor organizations affiliated with the Railway Employees' Department, American Federation of Labor, won recent elections supervised by the National Mediation Board on the Long Island and the Washington Terminal while the Brotherhood of Railroad Shop Crafts of America, Virginian System, was chosen in a third contest by the Virginian's carmen (including coach cleaners), their helpers and apprentices.

As a result of the election on the Long Island, the International Association of Machinists has been designated to represent machinists while the International Brotherhood of Firemen, Oilers, Helpers, Roundhouse & Railway Shop Laborers was chosen by the power house employees and railway shop laborers.

Equipment Depreciation Orders

EQUIPMENT depreciation rates for 21 railroads are prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15,100 Depreciation Charges of Steam Railroad Companies. The composite percentages, which are not prescribed rates, range from 3.03 for the Texas & New Orleans to 11.61 for the Osage. Also included among the 21 roads are the Cheswick & Harmar; the Sumpter Valley; the Akron, Canton & Youngstown; St. Joseph Terminal; New York, Chicago & St. Louis; Alton; Chicago, Indianapolis & Louisville; and Grand Trunk Western.

The above-mentioned 3.03 composite percentage for the Texas & New Orleans is derived from prescribed rates as follows: Steam locomotives (both owned and leased), 2.76 per cent; other locomotives, 9.46 per cent; freight-train cars (owned), 3 per cent—leased, 3.36 per cent; passenger-train cars (owned), 2.47 per cent—leased, 2.72 per cent; light-weight streamlined passenger-train cars (leased), 3.84 per cent; work equipment (owned), 3.72 per cent—(leased), 3.32 per cent; miscellaneous equipment, 10.35 per cent.

The A. C. & Y.'s composite percentage is 4.03; its prescribed rates: steam locomotives, 3.55; freight train cars, 5.69; passenger train cars, 3.83; work equipment, 3.61; and miscellaneous equipment, 17.96.

The Nickel Plate's composite percentage of 3.93 is derived from the following prescribed rates: Steam locomotives, 3.8 per cent; freight-train cars, 4.04 per cent; passenger-train cars, 3.1 per cent; work equipment, 4.43 per cent; miscellaneous equipment, 6.95 per cent. The Alton's composite percentage of 4.34 is derived from the following prescribed rates for owned and leased equipment, respectively: Steam locomotives, 5.09 per cent and 2.78 per cent; other locomotives (leased), 6.63 per cent; freight-train cars, 4.79 per cent and 2.5 per cent; passenger-train cars, 3.79 per cent and 2.74 per cent; work equipment, 3.23 per cent and 6.93 per cent; miscellaneous equipment (owned), 13.33 per cent.

The Monon's composite percentage is 3.67; its prescribed rates are as follows: Steam locomotives, 2.78 per cent; freight-train cars, 4.23 per cent; passenger-train cars, 2.87 per cent; work equipment, 3.92 per cent; miscellaneous equipment, 14.98 per cent. The Grand Trunk Western's composite percentage of 3.23 is derived from the following prescribed rates for owned and leased equipment, respectively: Steam locomotives, 3.28 per cent and 2.78 per cent; other locomotives (owned), 6.5 per cent; freight-train cars, 3.37 per cent and 3.11 per cent; passenger-train cars, 3.87 per cent and 3.16 per cent; work equipment (owned), 3.5 per cent; miscellaneous equipment (owned), 9.67 per cent.

The statement also lists Sub-order No. 189-A, which vacates Sub-order No. 189, dated June 17, 1935, relating to the Charlotte, Monroe & Columbia.

Supply Trade Notes

HOWARD G. HILL, sales and service engineer of the Miller Felpax Company, Winona, Minn., has been appointed mechanical engineer, in addition to his other duties.

◆

WATER JEHU, general manager of the Timken Roller Bearing Company, Ltd., Toronto, Ont., has been appointed district manager of the Timken Roller Bearing Company, with headquarters at Boston, Mass.

◆

THE CHICAGO RAILWAY EQUIPMENT COMPANY, Chicago, has entered into a contract with the Pullman-Standard Car Manufacturing Company whereby it will take over all Pullman patents covering car doors and door fixtures.

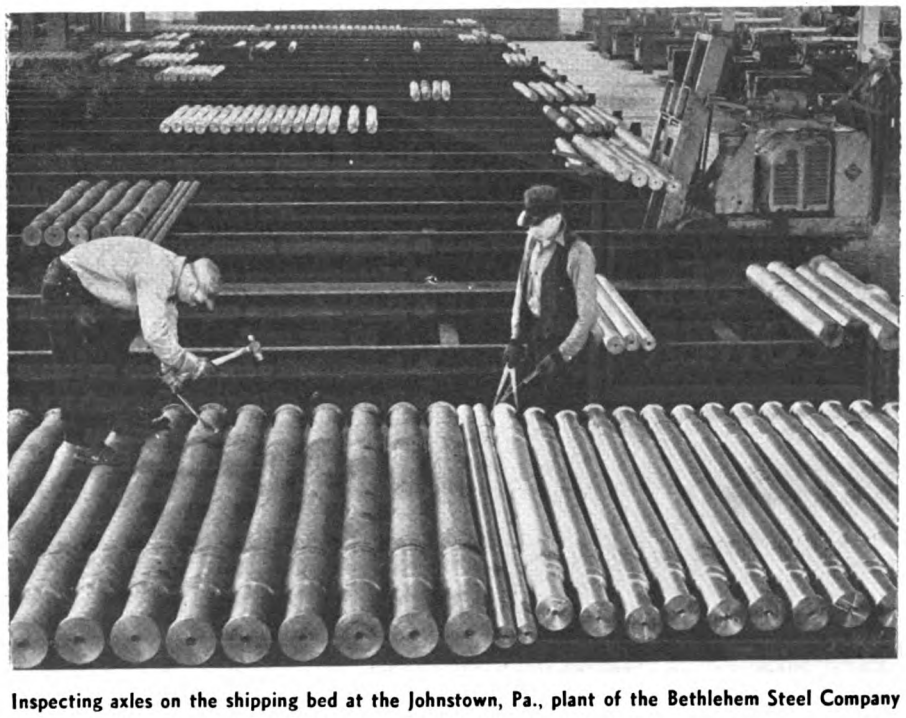
◆

HARRY L. FREVERT has been elected a member of the board of directors and the executive committee of The Baldwin Locomotive Works, to fill the vacancies caused by the resignation of George H. Houston recently. Mr. Frevert is president of The Midvale Company.

◆

THE BETHLEHEM STEEL COMPANY has recently completed a large expansion and modernization program at its Johnstown, Pa., axle plant. This includes additional equipment in the forging and heat-treating departments and an entirely modern axle-finishing shop. In the forging department the equipment includes an additional forging hammer and a charging machine. There are two new modern heat-treating furnaces. The axle-finishing shop is housed in a building having brick walls with large steel sash and saw-tooth roof. The floor is concrete with the surface hardened to withstand heavy trucking and prevent dusting, and wood blocks have been laid in front of all machines. There is a battery of cutting-off and centering machines; center-driven axle lathes, each having two tools at each end to permit the employment of a very slow feed without sacrifice of production; a battery of end-driven lathes for overall finishing, where required; boring mills with a capacity of 6-in. holes 126

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Inspecting axles on the shipping bed at the Johnstown, Pa., plant of the Bethlehem Steel Company

NEW HIGH R



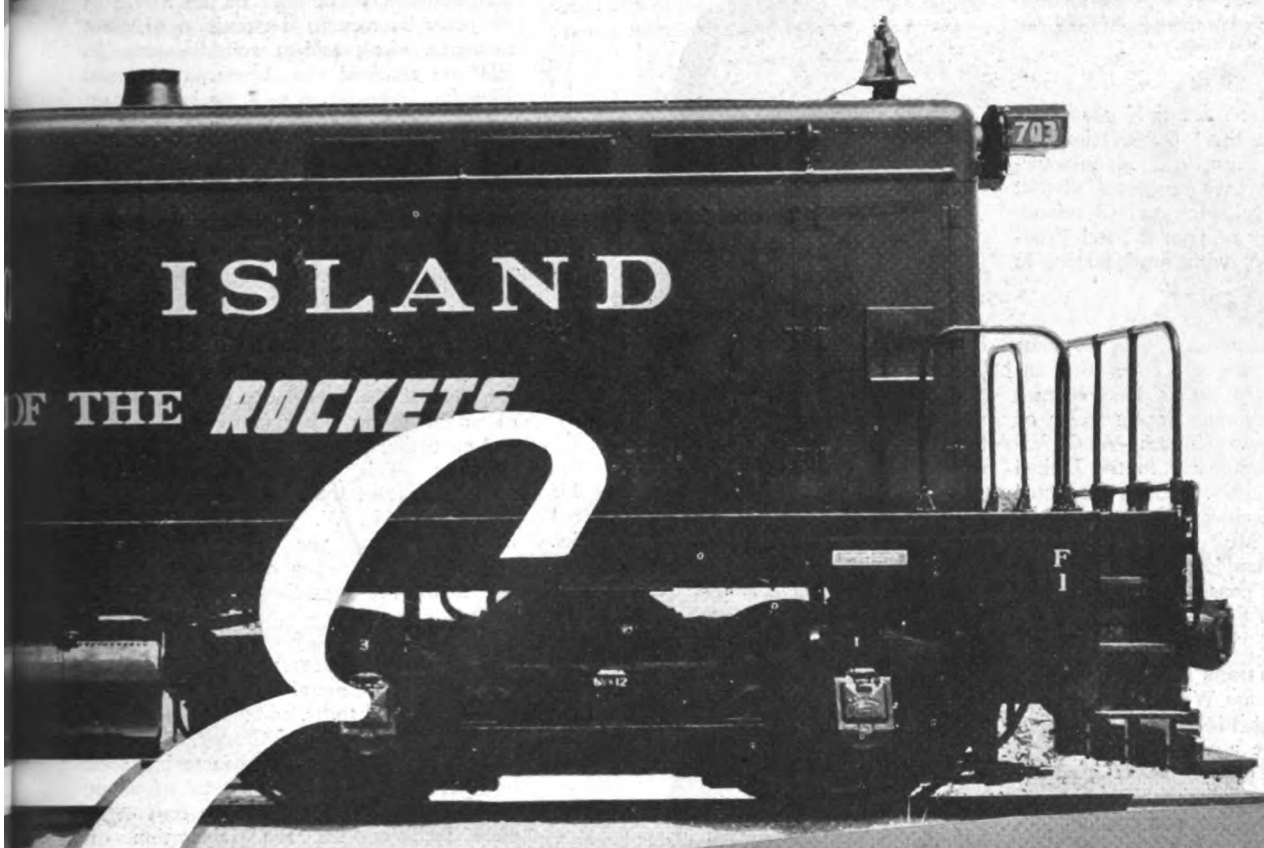
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DIESEL POWER

Railroads using EMC Diesel Switchers have definitely proved these clear-cut economies . . .

- Fuel costs normally reduced 75 per cent.
- Maintenance costs reduced 50 per cent.
- Enginehouse expenses, including lubricants, water, supplies,—reduced 66 per cent.
- Availability for service averages 94 per cent.
- Uniform efficiency throughout entire year.
- **Safer and faster operation through better visibility—absence of smoke and steam—higher initial tractive effort.**
- **Elimination of fire hazard and smoke complaints.**
- **Less track wear and fewer derailments.**
- **Combined tangible savings normally sufficient to liquidate the Diesel's first cost in 5 years.**

ELECTRO-MOTIVE
SUBSIDIARY OF GENERAL MOTORS

ECORDS *for*



Economy

● THE Rock Island now has 37 EMC Diesel Switchers in service . . . Each Switcher is saving $1,000.00 per month over and above carrying and amortization charges . . . Operating at an availability of 98 per cent, these 37 EMC Diesels have replaced 80 steam switchers . . .

CORPORATION

LA GRANGE, ILLINOIS, U. S. A.

in. long, and a grinding machine for overall finishing of axles for high-speed passenger equipment. The machines are served by overhead monorails with electric hoists, and the shipping bed adjoining the machine tools is served by an overhead crane. There is a stock yard with a storage capacity of about 1,500 tons.

◆

L. F. KINDERMAN, formerly associated with the Republic Steel Corporation and the Westinghouse Electric & Manufacturing Company, has been appointed district sales representative for the Cleveland-Pittsburgh territory of Iron & Steel Products, Inc., Chicago, with headquarters in Warren, Ohio.

◆

DR. A. GIESL-GIESLINGEN, who for some years has been serving as a consulting engineer in the United States, has returned to Austria as assistant sales manager of the Wiener Locomotiv Fabrik—A. G. Vienna. Dr. Giesl first came to the United States in October, 1929. He was connected with the Western Railway Equipment Company, St. Louis, Mo., doing special engineering work from 1930 to 1933. Since 1933 he served as consulting engineer for various companies.

◆

THE OWENS-ILLINOIS GLASS COMPANY and the Corning Glass Works have formed the Owens-Corning Fiberglas Corporation which will produce a variety of products made from fiber glass. These products will be marketed in such fields as household equipment, building construction, refrigeration insulation, air filters, and electric-power insulation, fields previously dominated by organic textiles and other materials. The products and processes are protected by basic patents.

The Gustin-Bacon Manufacturing Company, who in the past have been affiliated with the Owens-Illinois Glass Company in the distribution of Fiberglas products to the railroad industry, will act in the same capacity for the Owens-Corning Fiberglas Corporation.

The new corporation, the Owens-Corning Fiberglas Corporation, is financed jointly by Owens-Illinois and Corning and is an independent corporate structure which will not operate as a subsidiary of either parent company. The officers are: Chairman of the board, Amory Houghton, who is also president of the Corning Glass Works; president, Harold Boeschenstein, who has resigned as vice-president and general manager of the Owens-Illinois Glass Company; vice-presidents, Games Slayter, who has played a major part in the development of the new basic product, and W. P. Zimmerman, formerly general manager of the industrial products division of Owens-Illinois; general sales manager, G. E. Gregory, former sales manager of Corning; secretary, A. C. Freligh, former comptroller of fiber glass products of Corning; comptroller, H. R. Winkle, formerly assistant comptroller of Owens-Illinois. The principal offices of the company are at Toledo, Ohio. The New York offices are at 718 Fifth avenue. Other sales offices will be located at Boston, Mass.; Washington, D. C.; Chicago; Detroit, Mich.; Pittsburgh, Pa.; Cincinnati, Ohio, and San Francisco, Calif.

Amory Houghton was born on July 27, 1899, at Corning, N. Y. He was educated at St. Paul's School, Concord, N. H., and



Amory Houghton

Harvard University. After receiving his A. B. degree at Harvard in 1921 he entered the service of the Corning Glass Works. He was made assistant to the president in 1926 and became executive vice-president in 1928. He was elected president in 1930.

Harold Boeschenstein was born on July 21, 1896, at Edwardsville, Ill. He was educated at the University of Illinois,



Harold Boeschenstein

from which he received the degree of B.S. in 1920. He joined the Illinois Glass Company at Alton, Ill., in 1921, and the Owens-Illinois Glass Company in 1930 when the Owens Bottle Company and the Owens Glass Company were merged.

◆

WILLIAM S. JOHNSON, district manager of the American Car and Foundry Company, Berwick, Pa., retired at his own request on December 1. Mr. Johnson completed 53 years service in the employ of the American Car and Foundry Company, and its predecessor, during the last 17 of which he was in full charge of the Berwick district. He started his career in the rolling mill of the Jackson & Woodin Co., which later merged with other independents to form the American Car and Foundry Company. He rose through various steps until he reached the district managership on May 1, 1921. Guy C. Beishline has been appointed district manager in charge of the Berwick district, vice Mr. Johnson. Mr. Beishline began his career with the American Car and Foundry Company, but resigned in 1914 to join the Mt. Vernon Car and Manufacturing Co. In the course of 20 years he rose to the position of plant manager, vice-president and director. In 1937 he rejoined the American Car and Foundry organization as a special assistant on the staff of the vice-president in charge of operations, from which he is now promoted to the district managership.

◆

THE DIVISION OF ENGINEERING AND RESEARCH of the Crane Company held open house to several hundred scientists, educators, research men, engineers, business executives, and magazine and newspaper editors at the research and testing laboratories of the company at Chicago. The occasion of the event was the completion of an ambitious program of enlargement and extension of the company's laboratory facilities. This program of development has been carried forward under the general direction of L. W. Wallace, director of the Engineering and Research division, and formerly director of engineering research of the Association of American Railroads.

◆

THE ELECTRO-MOTIVE CORPORATION, a subsidiary of General Motors, has completed a 300,000 sq. ft. addition to its Diesel locomotive plant at La Grange, Ill. The addition increases the manufacturing area two-thirds, bringing it to a total of about 14 acres, and brings under one roof complete facilities for the fabrication of Diesel-electric switching and passenger locomotives, with the exception of certain castings and forgings which may be purchased more economically from outside sources due to the variety of their sizes and shapes.

The enlargement is the second since the plant was opened in January, 1936. Employment has increased to 2,000 from an original working force of 350. A total of 225 locomotives, developing an aggregate of 210,000 hp. has been turned out of the plant to date, the total value of these locomotives together with spare parts manufactured for stock, being $25,000,000. As enlarged and equipped, the plant now has a maximum capacity of one complete locomotive per working day.

Obituary

SAMUEL G. REA, vice president in charge of sales in the Eastern district, of the Standard Railway Equipment Company, Chicago, with headquarters in New York, died in that city on November 16.

◆

GEORGE THOMAS COOKE, president of the American Railway Products Company, Darien, Conn., died on November 8.

◆

CHARLES C. KINSMAN, assistant to the president of the Universal Draft Gear Attachment Company, Chicago, died suddenly on November 14 at his home in Chicago. He was a graduate of the Massachusetts Institute of Technology and had been with the company for 27 years.

Personal Mention

General

C. F. SPICKA, superintendent of shops on the Union Pacific at Cheyenne, Wyo., has been promoted to acting assistant general superintendent of motive power and machinery of the Eastern district, with headquarters at Cheyenne.

CLYDE BERTRUM HITCH, who has been appointed superintendent of motive power of the Chesapeake & Ohio at Richmond, Va., as noted in the November issue, was born at Terre Haute, Ind., on November 19, 1881. After serving his apprenticeship on the old Vandalia Line (now a part of the Pennsylvania) at Terre Haute, he



Clyde Bertrum Hitch

found employment as a machinist on various roads, entering the service of the C. & O. on September 1, 1902, as a machinist at Lexington, Ky. On April 1, 1909, Mr. Hitch was promoted to the position of general foreman, serving in this capacity successively at Lexington, Covington, Ky., and Hinton, W. Va. He was appointed master mechanic of the Clifton Forge division on January 1, 1921, and in November, 1923, became master mechanic of the Cincinnati division, including the Northern sub-division. In February, 1930, his headquarters were transferred to Russell, Ky., thus extending his jurisdiction over the Russell Terminal and the Ashland and Big Sandy divisions. He became general master mechanic, western general division in May, 1930, and in September, 1931, his jurisdiction was extended to the eastern general division. On January, 1934, he was appointed assistant superintendent of motive power at Huntington, W. Va.

JOHN GOGERTY, assistant general superintendent of motive power and machinery of the Eastern district of the Union Pacific, with headquarters at Cheyenne, Wyo., has been transferred to Pocatella, Idaho, with jurisdiction over the South-Central and Northwestern districts.

Master Mechanics and Road Foremen

E. A. SCHRANK, master mechanic on the Chicago, Burlington & Quincy at Galesburg, Ill., has been transferred to Casper, Wyo., succeeding William Schwartz, who returned to his former position as enginehouse foreman at that point.

C. D. ALLEN, has been appointed assistant master mechanic of the Chesapeake & Ohio at Clifton Forge, Va.

J. E. MCLEOD, assistant master mechanic on the Chesapeake & Ohio at Stevens, Ky., has been transferred to Peru, Ind.

FRANK J. TOPPING, assistant master mechanic of the Chesapeake & Ohio, with headquarters at Hinton, W. Va., has been transferred to Stevens, Ky.

F. J. CARTY, master mechanic of the Boston & Albany, with headquarters at Boston, Mass., was born on January 10, 1882, at Boston. He attended Boston public schools, and is a graduate of Mechanic Arts High School (1899). He took a post graduate course; and in 1904 received a B.S. degree in mechanical engineering from the Massachusetts Institute of Technology. Mr. Carty entered the employ of the Boston & Albany on November 7, 1904, as a draftsman in the office of the superintendent of motive power and vice-presi-



F. J. Carty

dent at Boston. He became mechanical engineer of the B. & A., on October 26, 1907, and master mechanic in October, 1938. Mr. Carty was president of the New England Railroad Club from March, 1926, to March, 1927.

STANLEY M. HOUSTON, newly appointed master mechanic of the Southern Pacific at Oakland, Calif., was born at Albuquerque, N. M., on June 5, 1898. He was educated in the public schools in Arizona and took a four-year night course in mechanical engineering. Mr. Houston entered the employ of the Southern Pacific on April 1, 1913, as a machinist apprentice at Globe, Ariz. Upon the completion of his apprenticeship in May, 1917, he served at Globe until April, 1920, as a machinist; until April, 1922, as enginehouse foreman; until April, 1923, as general foreman; and until October, 1924, as master mechanic. In the latter year he was appointed superintendent of general shops of the Southern Pacific of Mexico with headquarters at Empalme, Sonora, Mex. In July, 1927, he became superintendent of motive power at Sonora,



Stanley M. Houston

and in April, 1936, was transferred to Guadlajara Jalisco, Mex., as assistant general manager. He returned to the United States in May, 1937, as assistant master mechanic of the Southern Pacific at Oakland, Calif.

Obituary

JULIUS H. REISSE, retired mechanical assistant to the executive vice-president of the Chicago, Burlington & Quincy, died at Chicago on November 3, following a long illness. Mr. Reisse was born on October 14, 1880, and studied mechanical engineering through the International Correspondence Schools. After serving with the Pullman Company from 1899 to 1905, he entered the service of the Burlington in the latter year as a draftsman at Aurora, Ill.,



Julius H. Reisse

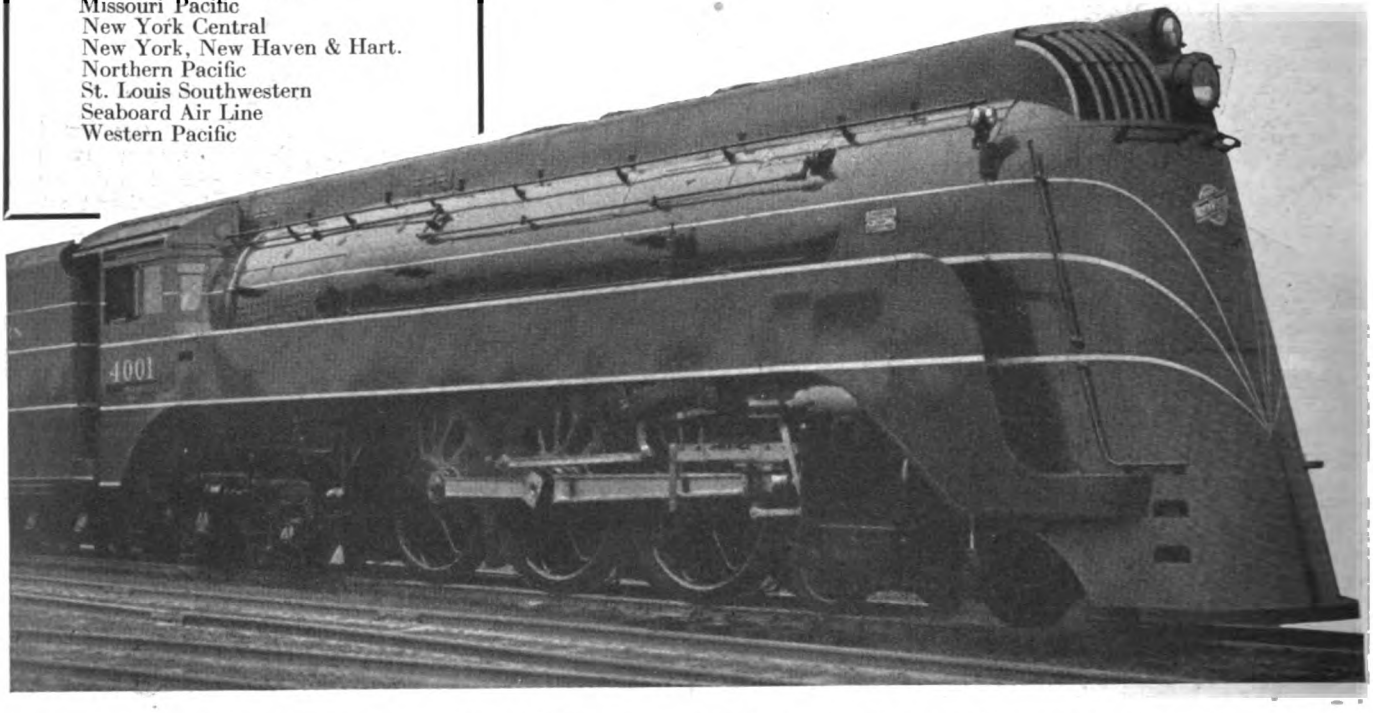
later being transferred to Chicago. In December, 1905, he was appointed leading draftsman, and in May, 1918, was advanced to chief draftsman. Mr. Reisse became mechanical inspector in May, 1925, and on March 4, 1926, was appointed mechanical assistant to the vice-president, retiring from the latter position in May, 1936.

Known by the Company They Keep

In the Service of MODERN POWER

Atchison, Topeka & Santa Fe
Atlantic Coast Line
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Canadian Pacific
Chicago, Burlington & Quincy
Chic., Mil., St. Paul & Pac.
Chicago & North Western
Denver & Rio Grande Western
Delaware, Lackawanna & West.
Kansas City Southern
Missouri Pacific
New York Central
New York, New Haven & Hart.
Northern Pacific
St. Louis Southwestern
Seaboard Air Line
Western Pacific

BARCO PRODUCTS



The name "Barco" is closely associated with many of the finest, most modern locomotives and trains operating on the North American continent.

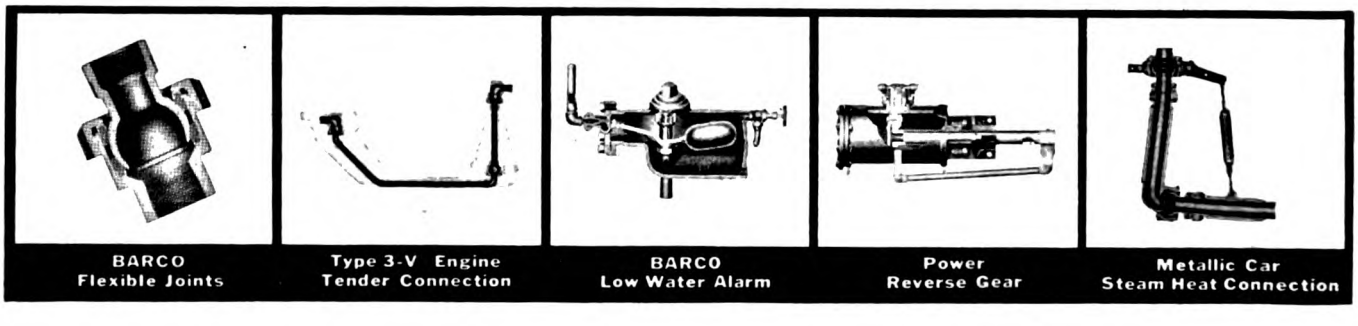
This general acceptance of BARCO products in most exacting services, is a natural outgrowth of many years' successful solution of numerous mechanical and operating problems of the railroads.

They are precision products—consistently dependable and economical—and contribute materially to the efficiency, comfort and safety of modern equipment.

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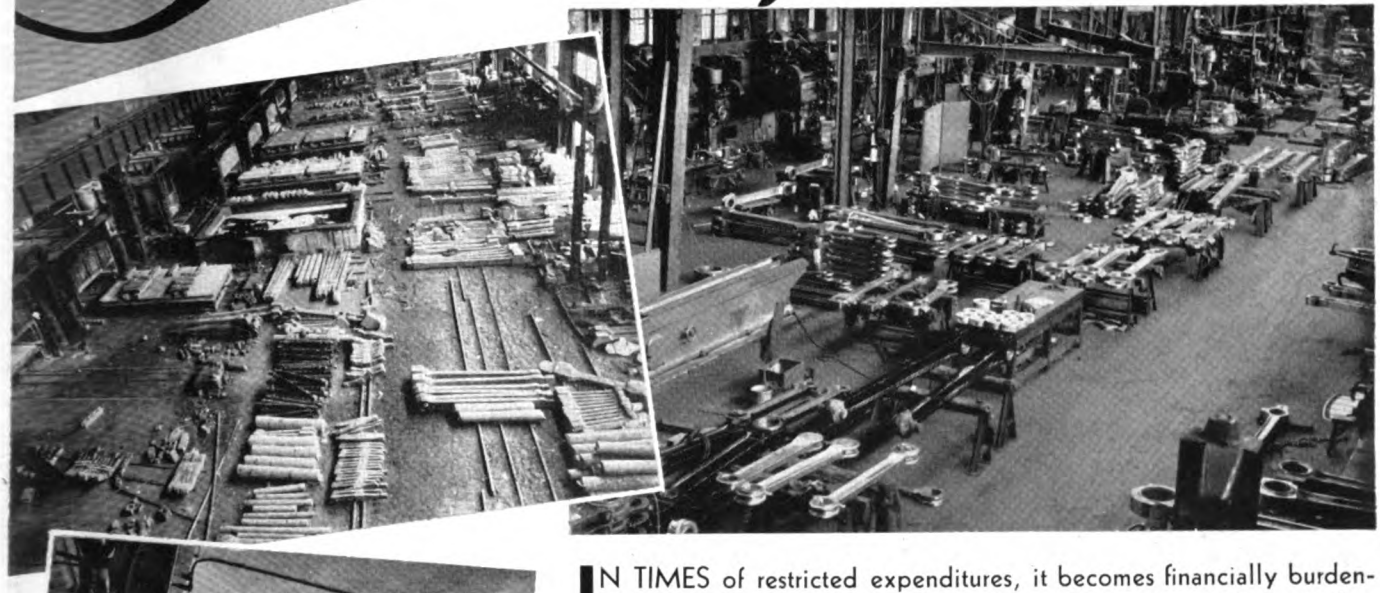
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ALCO SERVICE on Forgings

Will help solve vital problems within your own shops • • •

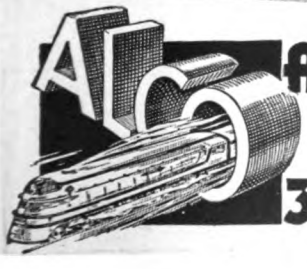




IN TIMES of restricted expenditures, it becomes financially burdensome to keep all railroad forge shops tooled-up for maximum quality and low cost production.

But with ALCO it's different. As builders of all types of modern locomotives, ALCO must, of necessity, keep its entire manufacturing and testing facilities right up to the minute to produce the finest locomotive forgings money can produce. It is these ultra-modern plant facilities backed by a century of experience and a specially trained personnel which make up ALCO Service and which you can depend upon for your main and side rods, piston rods, axles, wrist pins, crank pins and other forgings.

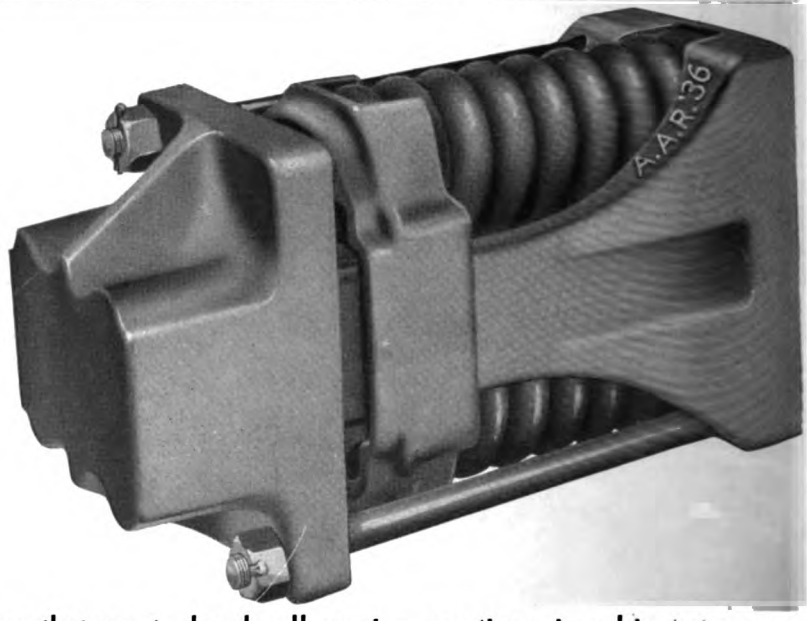
ALCO Service is accurate—prompt—economical. In short it's just good business to buy ALCO Forgings.



AMERICAN LOCOMOTIVE COMPANY

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NATIONAL A.A.R. APPROVED DRAFT GEARS



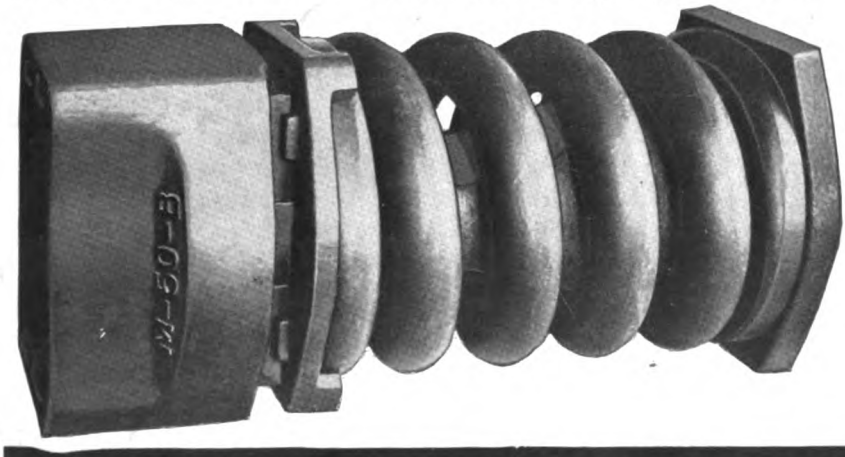
NATIONAL M-17-A DRAFT GEAR
22⅜" long
A.A.R. Approved

NATIONAL Draft Gears are necessarily sturdy in design to satisfactorily meet present day service requirements at lower cost.

The friction segments act inwardly against the sturdy friction member, with the result that this important member that must absorb all service reactions is subject to compressive stresses.

The M-17-A and M-50-B draft gears are basically of the same design and are adapted for service in cars having A.A.R. standard size draft gear pockets. The M-17-A draft gear is 22⅜ inches long and requires one standard follower. The M-50-B draft gear is 20⅛ inches long and requires two standard followers. This gear also may be used in cars having certain non-standard draft gear pockets.

National Draft Gears are manufactured to rigid specifications. All functional parts are accurately heat treated to withstand the most severe service. When you use these gears in your cars you are assured of highly dependable service at low cost.



NATIONAL M-50-B DRAFT GEAR
20⅛" long
A.A.R. Approved

NATIONAL MALLEABLE AND STEEL CASTINGS CO.
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Railway Mechanical Engineer

FOUNDED IN 1832

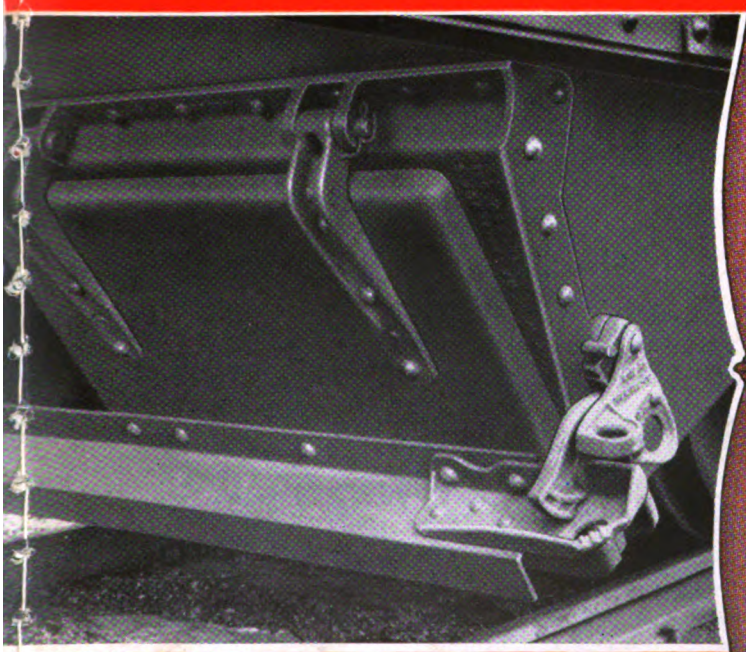
IME IS WASTING AWAY YOUR LADING

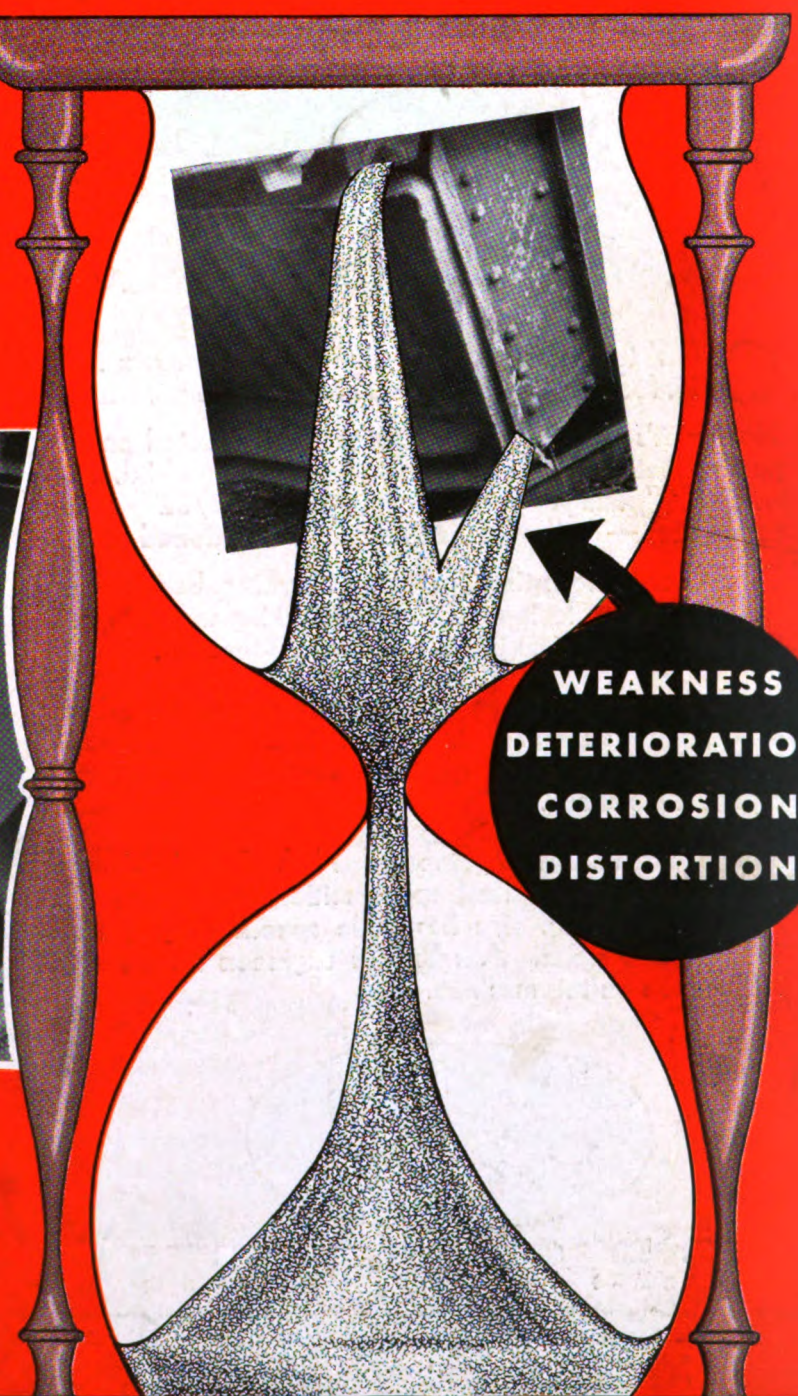
STOP IT

WITH

VINE HOPPER

FRAMES





WEAKNESS
DETERIORATION
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NCREASED STRENGTH
PERMANENCE
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E WINE RAILWAY APPLIANCE CO. • TOLEDO, OHIO



Rod Bushings Machined Almost As Fast As You Can Peel APPLES



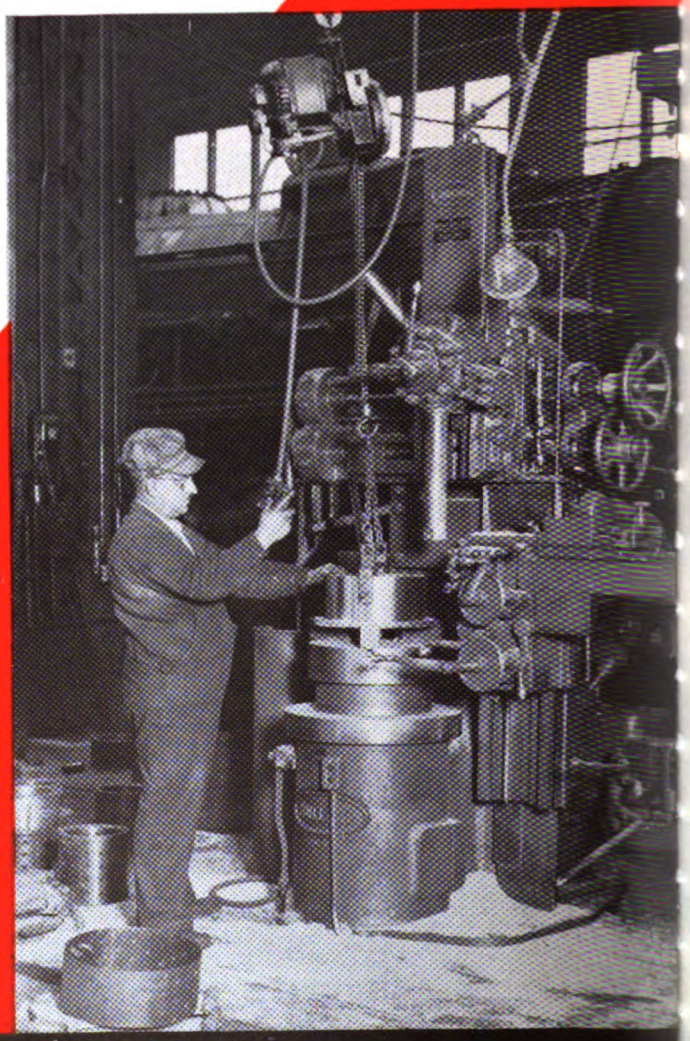
ONLY takes a moment to check—150 r.p.m. x .042 in. feed = 6 inches of machined surface per minute.

Now—let's check the time on the job illustrated on this page—floating rod bushing 13½" o.d. x 10⅜" i.d. x 6" with 1½" flange—rough boring cut = 3/32" rough turning cut — ⅛"—feed and speed as mentioned above.

Total floor to floor time including chucking, boring, turning, facing top, facing the flange, checking with template and removal requires just 3 min. and 10 seconds.

Finish cuts are not taken until the grease holes have been drilled and counter-sunk. The unit is a special 24" V.T.L. built to railroad specifications and equipped with a pneumatic chuck.

The new BULLARD Standard High Speed Vertical Turret Lathes offer unusual opportunities of reducing repair costs. The 24 in. size has table speeds ranging from 7.65 to 250 r.p.m. Ask Bullard engineers for detailed information on this machine.



BULLARD

R.R. SHOP UNITS

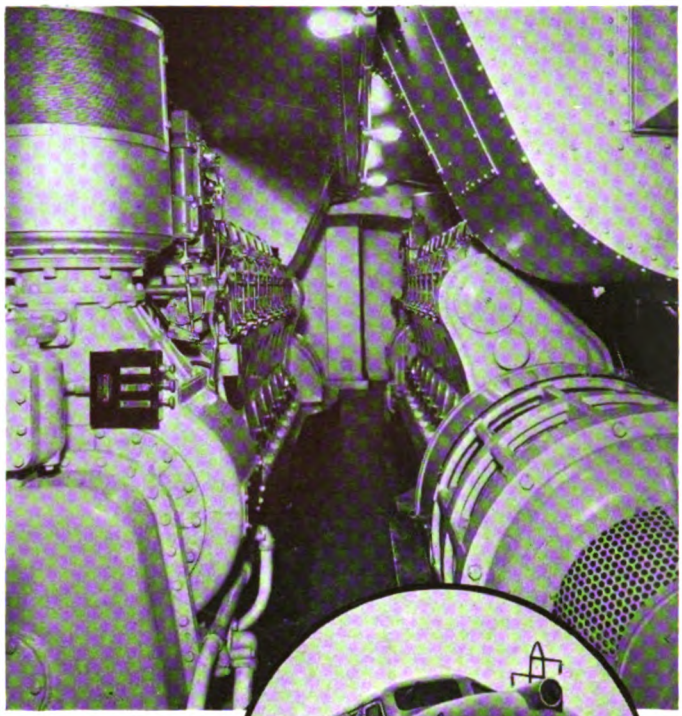
THE BULLARD COMPANY

BRIDGEPORT, CONNECTICUT

DO YOU CLEAN

DIESEL WATER JACKETS

THIS SAFE, EASY OAKITE WAY?



Every Superintendent of Motive Power, Diesel Maintenance Foremen and others responsible for the efficient operation of Diesel powered units should investigate this proved, successful Oakite method for keeping engines cool.



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Steam Cleaning Locomotive Running Gear

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WRITE TODAY!

Water Scale, Rust, Sediment and Other Deposits Safely Removed From Water Cooling Systems of Diesels

Experience shows that radiator cooling units and water jackets of Diesel engines which power streamliners or switch engines acquire, over a period of time, water scale, rust, sediment and other deposits. The insulating effect of these deposits hinders proper cooling and causes high engine temperatures that lower operating and power efficiency.

Successful, safe Oakite methods for removing water scale and other deposits from Diesel engine cooling systems have been developed and are now being used by a number of roads. Let us send you further details on this important phase of Diesel maintenance. There is no obligation . . . won't you write us today?



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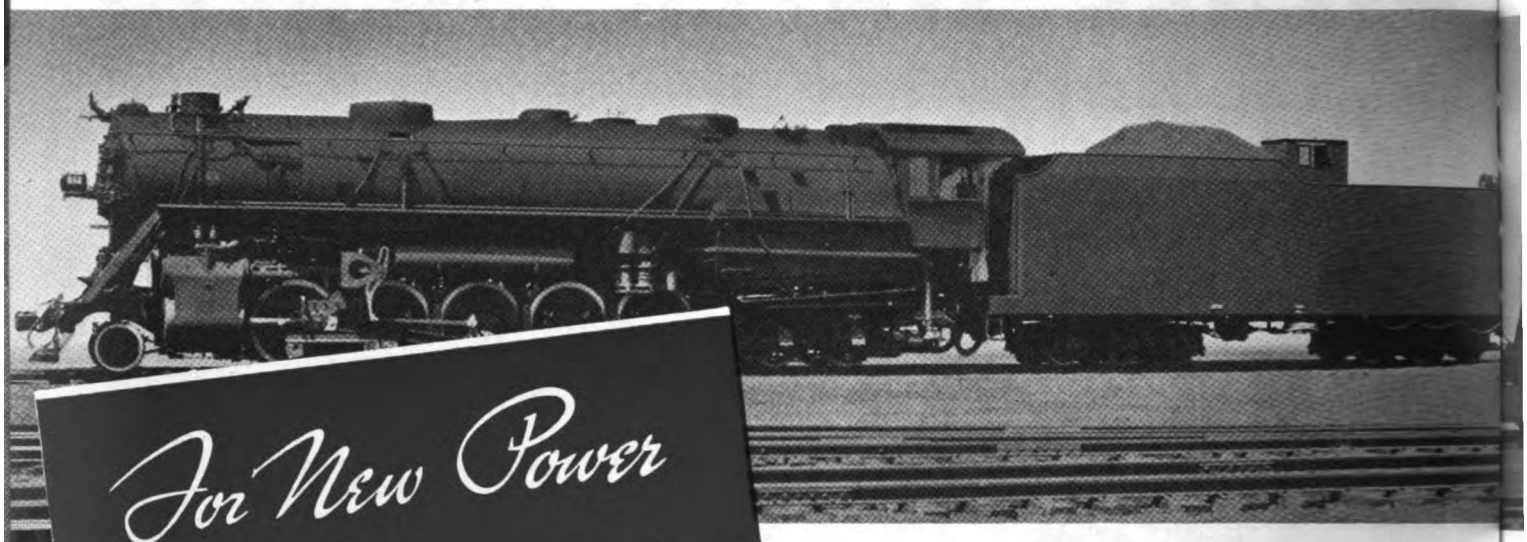
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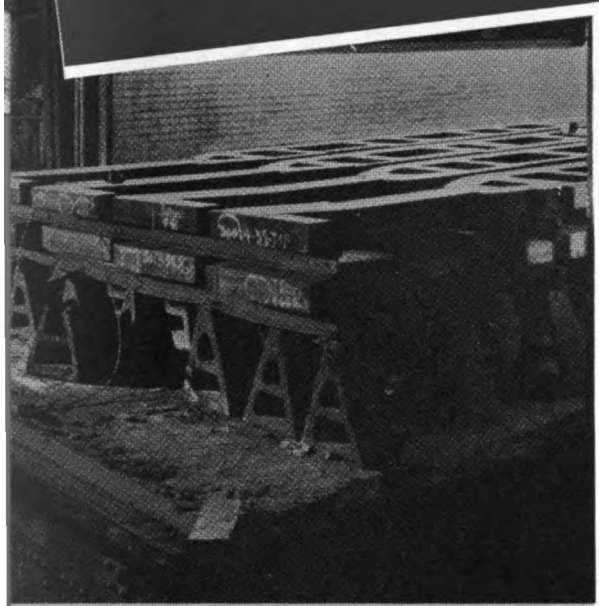
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U·S·S Locomotive Frames of



For New Power



Eight U·S·S Rolled Steel Frames going into car bottom type furnace for heat treatment. Note that extra metal left on frames, from which test pieces are taken, receives same treatment as frames.

CASE No. 1. A New Texas Type Locomotive

Weights, in working order:—

On driving wheels	*369,100 lb.*
On engine truck	*38,300 lb.*
On trailer truck	*112,600 lb.*
Locomotive and Tender	*903,900 lb.*

EACH of the U·S·S Frames for these locomotives was made from a single rectangular plate of wrought and rolled carbon steel—6½" x 36¾" x 438½"—weighing 24,675 lb.

To insure the greatest possible homogeneity and strength, the steel was converted from ingots into slabs by two separate rollings—sufficient discard was taken from each ingot and slab to insure freedom from piping and undue segregation—slab was then heated and rectified for flatness. Gas cutting to frame contour was performed with the slab held at approximately 600°F.

After cutting, frames were put through three heat treating cycles consisting of a double normalizing and temper, again rectified and tested to meet following minimum physical properties:—

Yield Point	Tensile Strength	Elong. in 2"
40,000 lb. p.s.i.	75,000 lb. p.s.i.	25%

Red. of Area	Cold Bend
45%	180°—D ½"

These physical properties are uniform throughout entire frame.

The frames—6½" thick, weighing 13,230 lb. each, were planed to 6" thickness, slotted, drilled and fitted by locomotive builder.

• • •

Here's what the Superintendent of Motive Power says about them. ***"These locomotives with U·S·S Rolled Steel Frames have been in service since early in 1937 and have given complete satisfaction, with 100% availability for service. No defects have developed. We have encountered no loose bolts or fastenings and have reason to believe the frame construction satisfactory in every respect."***

These 6 advantages distinguish U·S·S Rolled Steel Locomotive Frames

1. *Low first cost*, especially where only a few locomotives are built or when cylinders or frames are renewed—because no expensive patterns or molds are necessary.
2. *Low maintenance charges* throughout the life of the locomotive—due to the practical elimination of repairs and renewals on account of failure.
3. *Less weight* due to the fact that the superior physical qualities of rolled steel make it possible to reduce section with safety.
4. *Greater margin of safety* and durability as a result of the inherent superiority of rolled steel which is free, throughout, from imperfections and possesses a high degree of homogeneity.
5. *Less rigidity*—greater flexibility to safely absorb shocks, impacts, weave and vibration.
6. *Ease of installation* of part-frame sections when existing frames are renewed or repaired.

U·S·S LOCOMOTIVE FRAMES

Rolled OPEN-HEARTH Steel



For Permanent Repairs

CASE No. 2. A Re-framed Mallet Type Locomotive

Weights, in working order:—

Locomotive and Tender ..... *739,000 lb.*
Locomotive ..... *390,300 lb.*

THE four rectangular plates furnished for this typical major repair were of nickel steel, S.A.E. 2035—5½″ x 34″ x 276″—total weight, 59,357 lb. Double converted—sufficient discard removed—put through three heat treating cycles—rectified for flatness and tested to meet the following minimum physical properties:—

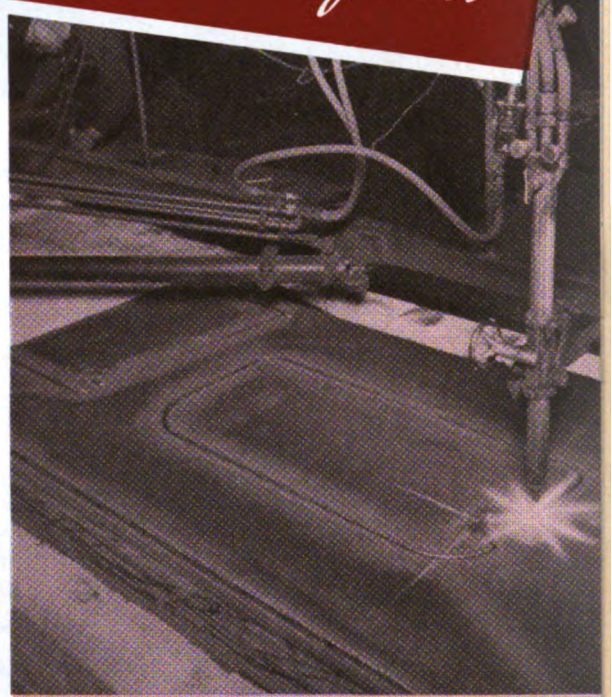
Yield Point	Tensile Strength	Elong. in 2″	Red. of Area
55,000 lb. p.s.i.	80,000 lb. p.s.i.	25%	50%

These physical properties are uniform throughout entire plate.

Plates were delivered to the railroad shop where they were gas cut to contour, stress relieved at temperature below final draw which left physical properties undisturbed, then planed to 5″ thickness and finish machined. Photomicrographic tests proved that heat penetration on cut surfaces did not exceed ¼″. No slotting necessary on weight saving openings. Therefore, *no extra machining costs.*

For re-framing locomotives we will furnish:—

1. Rectangular plates, heat treated as described above.
2. Frames, either full length or in section, gas cut to contour with stock allowed for finish machining.
3. Frames, gas cut and finish machined.
4. Frames, gas cut and finish machined, with pedestal binders and all attachments, ready for installation under locomotives.



Gas cutting U·S·S Locomotive Frame from solid steel plate. Metal template guides "Travograph" in cutting exact size required.

CARNEGIE-ILLINOIS STEEL CORPORATION

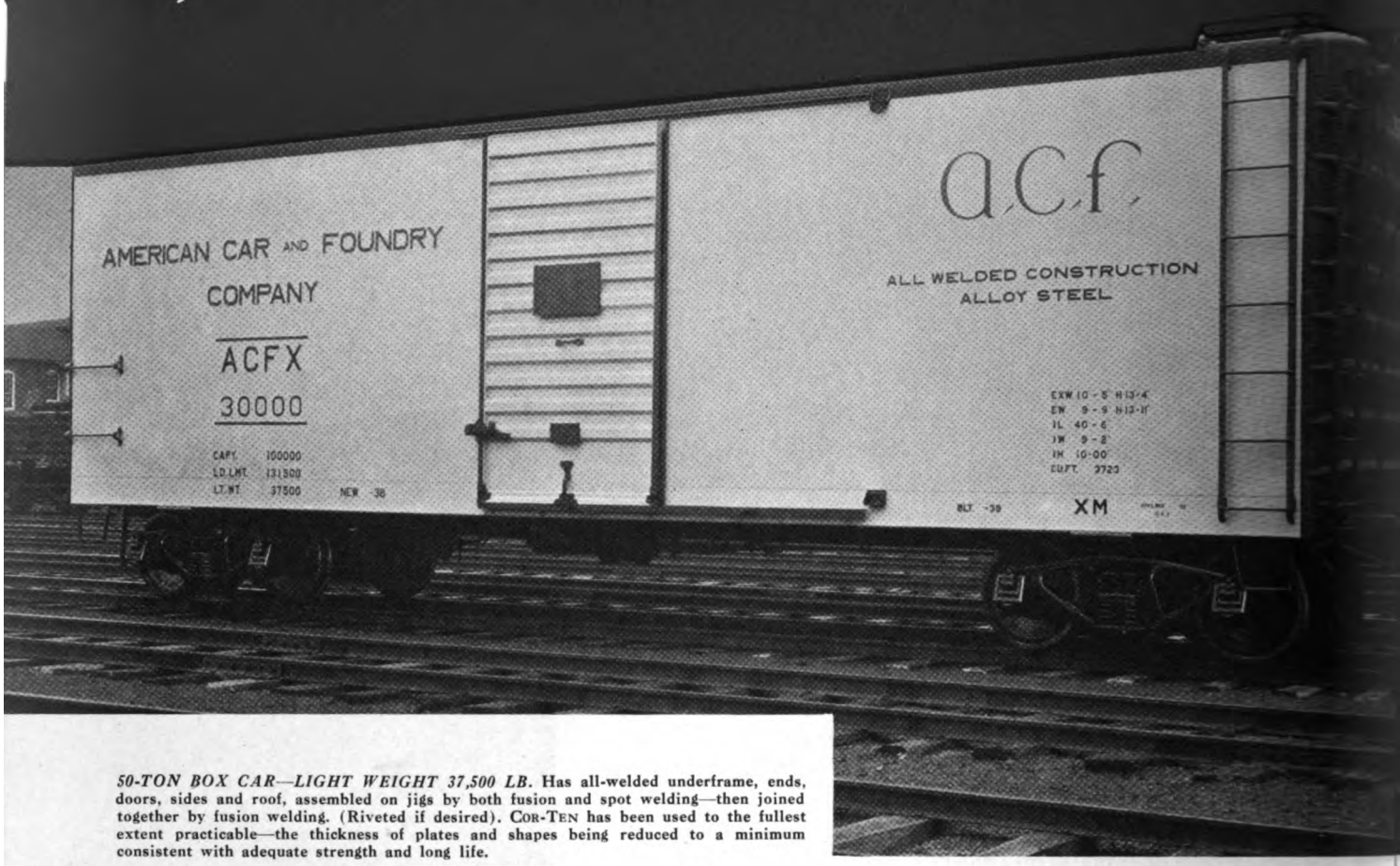
Pittsburgh · Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

USS

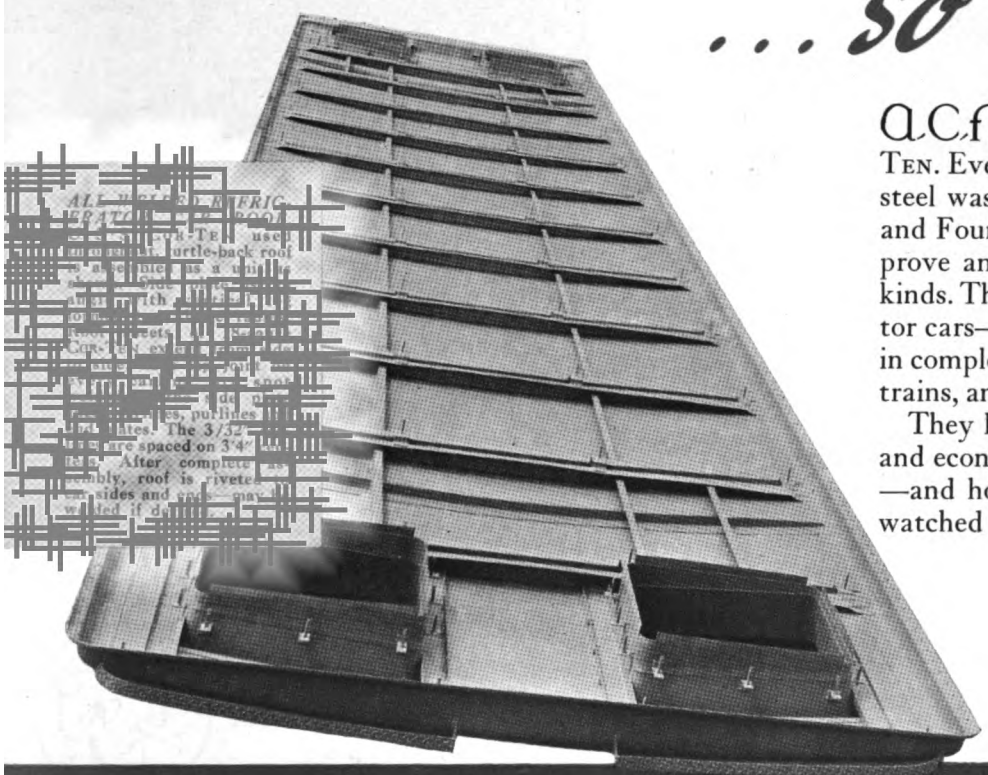
UNITED STATES STEEL

They wanted light weight-strengt



50-TON BOX CAR—LIGHT WEIGHT 37,500 LB. Has all-welded underframe, ends, doors, sides and roof, assembled on jigs by both fusion and spot welding—then joined together by fusion welding. (Riveted if desired). COR-TEN has been used to the fullest extent practicable—the thickness of plates and shapes being reduced to a minimum consistent with adequate strength and long life.

. . . so of course



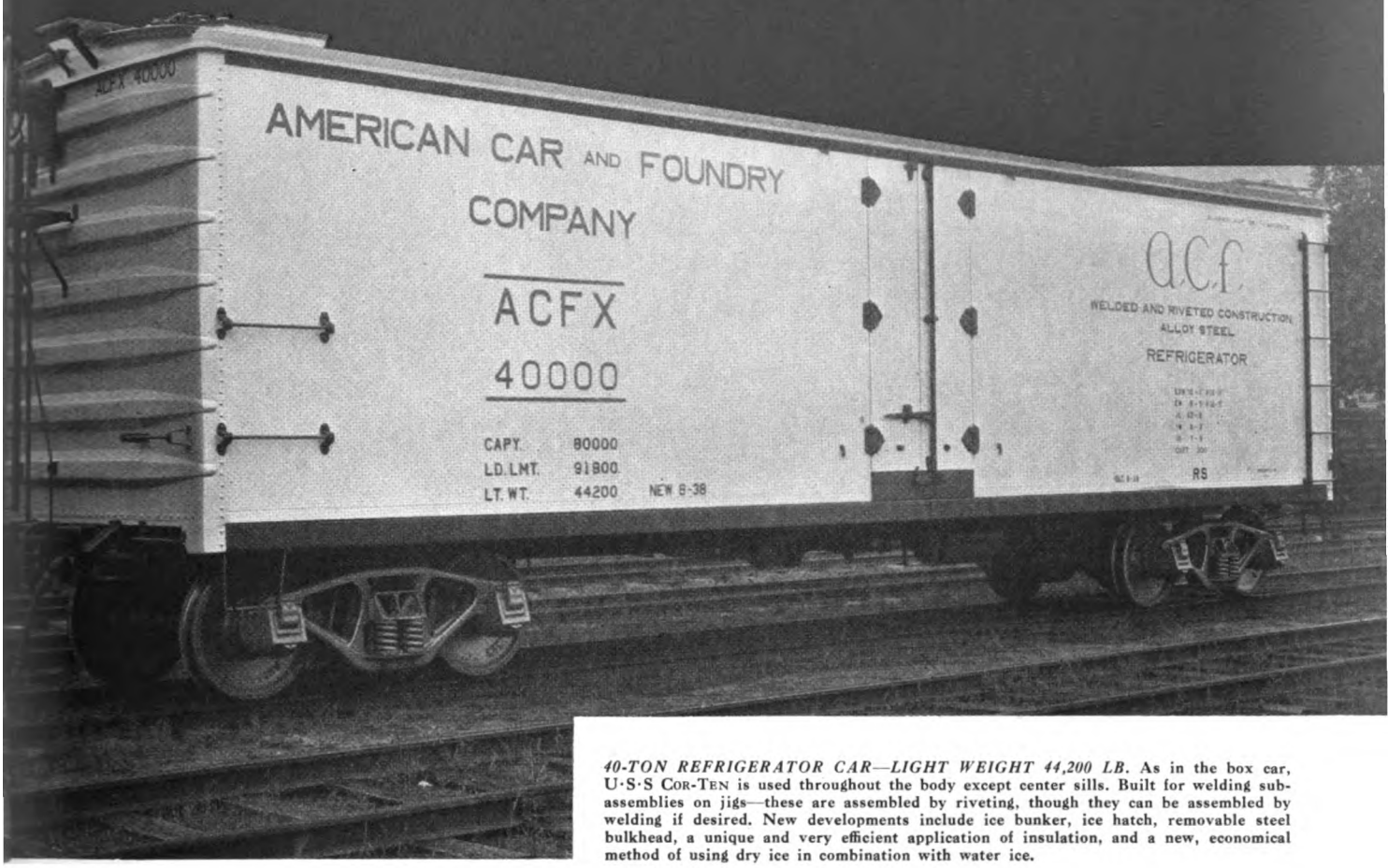
a.c.f. engineers know a lot about U·S·S COR-TEN. Ever since this pioneer low-alloy, high tensile steel was first put on the market, American Car and Foundry Company has used COR-TEN to improve and modernize transport equipment of all kinds. They've used it in hopper cars—in refrigerator cars—in rail cars, street cars, subway cars and in complete streamliners such as the later "Rebel" trains, and the famous "Abraham Lincoln."

They know what COR-TEN will do—how easily and economically it fabricates—how little it costs—and how well it stands up in service. They've watched it perform on all kinds of equipment—

USS

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corrosion resistance-low cost



40-TON REFRIGERATOR CAR—LIGHT WEIGHT 44,200 LB. As in the box car, U·S·S Cor-Ten is used throughout the body except center sills. Built for welding subassemblies on jigs—these are assembled by riveting, though they can be assembled by welding if desired. New developments include ice bunker, ice hatch, removable steel bulkhead, a unique and very efficient application of insulation, and a new, economical method of using dry ice in combination with water ice.

they chose COR-TEN!

they have seen it justify every claim made for it.

So when they built these new light-weight, all-welded box and welded-riveted refrigerator cars, they naturally turned to U·S·S Cor-Ten.

Taking advantage of the high strength and high corrosion resistance of Cor-Ten, a.c.f. designers trimmed tons of dead weight off the body structure—without sacrificing strength or stamina. In the box car, re-design using Cor-Ten construction shows 7,800 lb. saving in weight compared to the conventional riveted A.A.R. car—with equivalent increase in payload capacity. Its ratio of lading to rail load is 77.8% instead of 73.1% The new refrigerator car is 8,600 lb. lighter than a similar capacity, riveted, light car built only two years ago. And in this construction, the fact that Cor-Ten, under combined atmospheric and brine-spray conditions, is twice as effective in resisting deterioration as copper steel, definitely assures low maintenance.

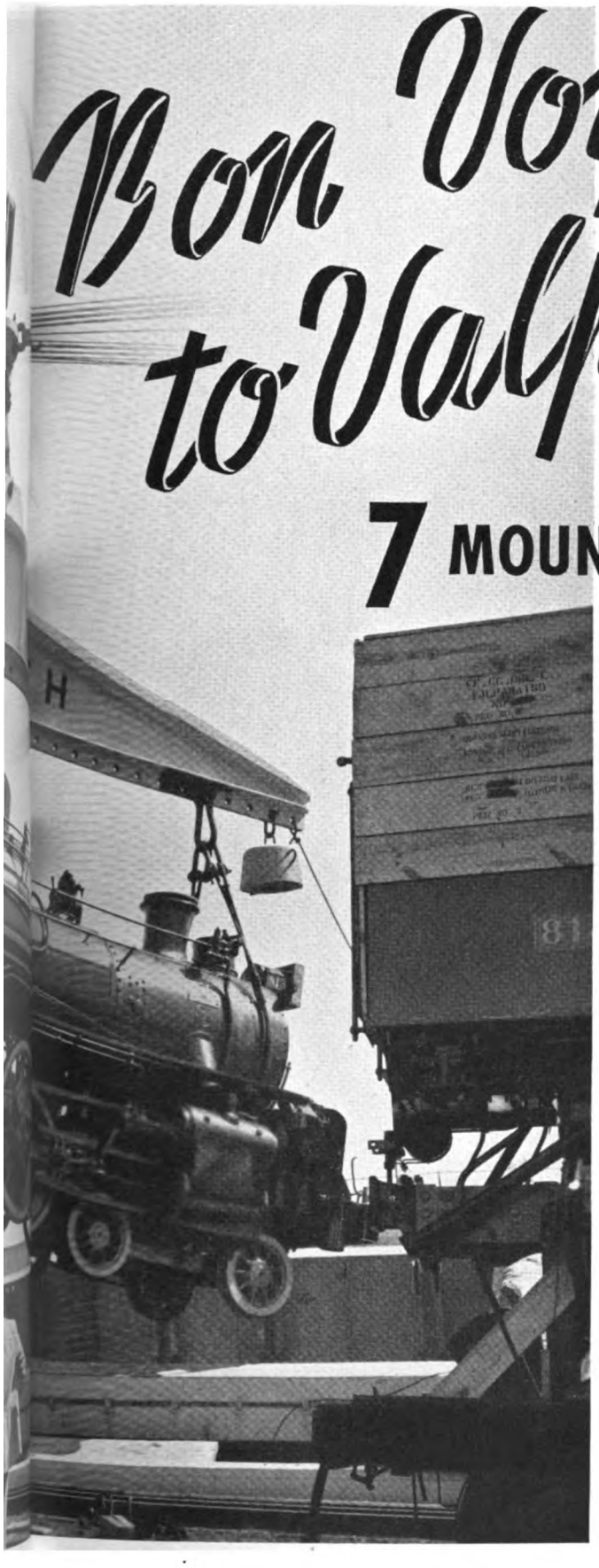
If you want to modernize your equipment—reduce its weight—increase its payload capacity—minimize operating and maintenance costs—build with Cor-Ten. Adaptable to modern, high-speed methods of fabrication, Cor-Ten can be handled as successfully as ordinary steel. We'll be glad to show you where and how best to use it.

U·S·S HIGH TENSILE STEELS



THE BALDWIN LOCOMOTIVE W

Bon Voyage to Valparaiso!



7 MOUNTAIN TYPE LOCOMOTIVES FOR THE CHILEAN STATE RAILWAYS

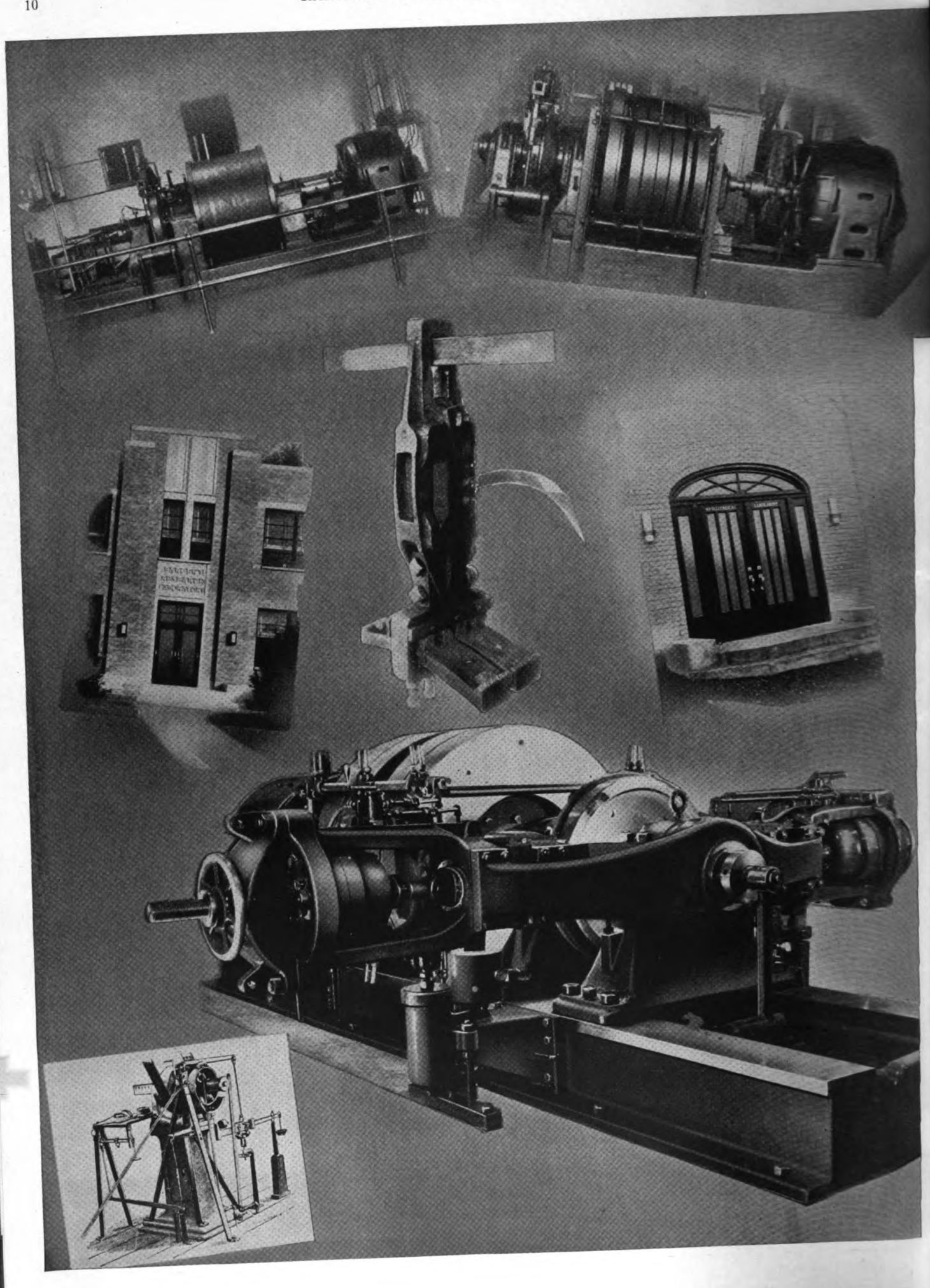
Order received
March 21, 1938

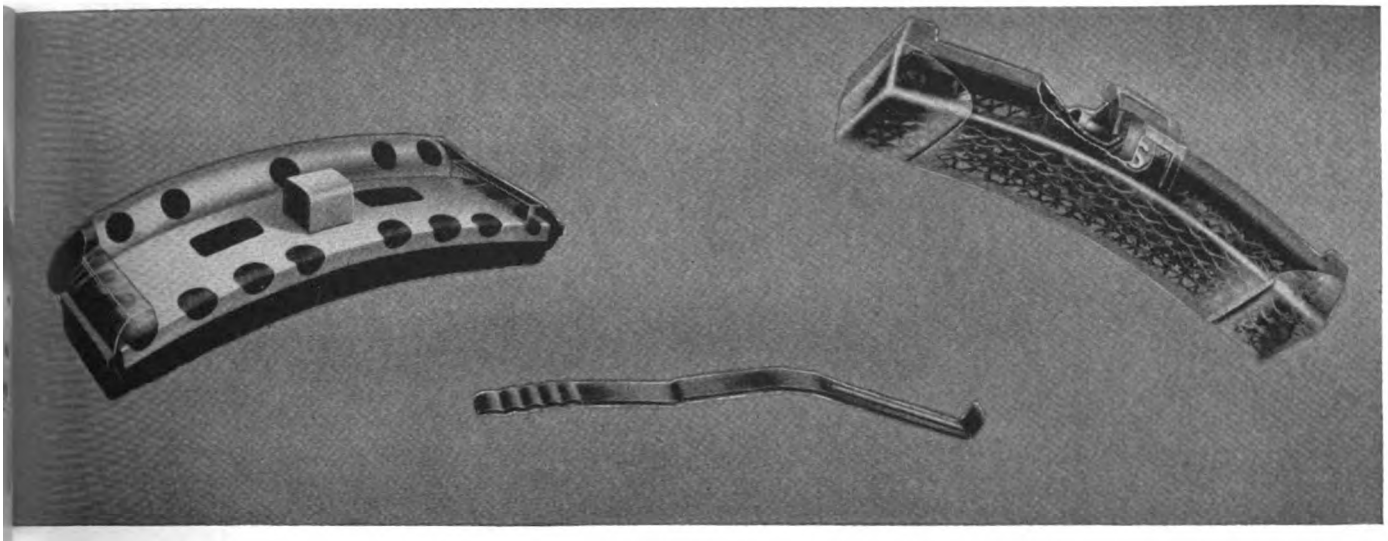
All details settled
April 16, 1938

First locomotive completed
July 14, 1938

All seven ready for shipment
August 4, 1938

VE WORKS • • • PHILADELPHIA





50 years ago

Fifty years ago the late F. W. Sargent, for many years Chief Engineer of this company, designed and built the first brake shoe testing machine.

Thirty years ago we placed our first full scale brake shoe testing machine in operation. This machine, modified and improved, was the point from which notable brake shoe improvements began.

Laboratories, both metallurgical and physical, have been built and, recently, we placed in operation a new and specially designed brake shoe testing machine. This machine has a capacity and sensitivity far greater than any other built up to this time. With this highly specialized equipment, brake shoe research will continue in order to anticipate the needs of tomorrow.

Notable recent improvements made by our Engineering Department are—

1. Samson reinforcement for driver shoes—to hold the body metal of the shoe intact until worn out.
2. An improved method of protecting steel backs and inserts from burning by the molten iron in manufacture.
3. The Duplane reinforcement for freight shoes—to eliminate premature failure of brake shoes in freight service.
4. The Brake Shoe LOCKEY—to prolong brake head life and minimize breakage and loss of car shoes in freight car service.

Write to 230 Park Avenue, New York, N. Y., for brochure of the new brake shoe testing machine.

THE AMERICAN BRAKE SHOE AND FOUNDRY COMPANY

BRAKE SHOE AND CASTINGS DIVISION

DRIVING POWER MEETS CLEANING POWER



Like washing an elephant, cleaning a locomotive is a big job. It calls for a metal cleaner with unusual qualities.

Wyandotte Engine Washing Compound will tackle a very big engine, cab, tank, jacket—as well as running gear—at *very small cost.* Because it does not *attack* the *finish,* because it leaves a *bright dry* surface that won't pick up road dirt—because a little goes a long way—railroads are switching their engines onto the Wyandotte cleaning track.

And they are on the right track. There are several Wyandotte Metal Cleaners—each one is built for a specific job—each one will save you money. A call to your Wyandotte Service Representative will bring an answer to your railway-cleaning problems.

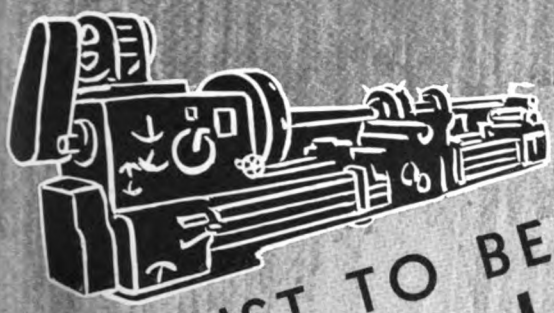


THE J·B·FORD COMPANY

WYANDOTTE MICHIGAN

DISTRICT OFFICES IN 26 CITIES





JUST TO BE DIFFERENT we give HALF this page to YOU!

It's the popular custom to show a picture of a tool, glorify its virtues, quote its percentages of savings and hope to heaven that the impression will encourage an inquiry. Just this once we want to be different. We show the picture merely to indentify that LeBlond makes good Lathes. The rest of this space we turn over to you.

You tell us about your problems!—What your present lathe operations are!—What you think you'd like to accomplish in performance, precision, cost reduction! If what we make fits into your picture, we'll tell you how and why...but only at your request. If you like, you can tell us what your experience has told you about LeBlond Lathes. That's up to you. It's your turn now. This is on us. Shoot!

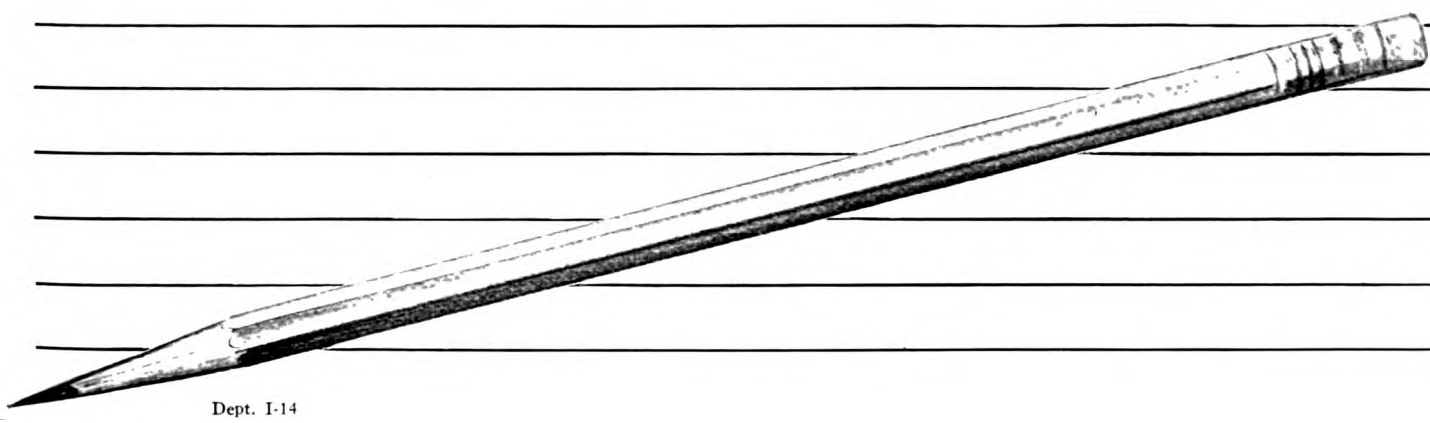
The R. K. LeBlond Machine Tool Co.
CINCINNATI, OHIO

CHECK THE MEMO FOR DETAILED LITERATURE

- ☐ ENGINE LATHES
- ☐ TOOL ROOM LATHES
- ☐ GAP LATHES
- ☐ SLIDING BED GAP
- ☐ RAPID PRODUCTION
- ☐ MULTI-CUT LATHES
- ☐ AUTOMATIC LATHES
- ☐ TURRET LATHES
- ☐ HOLLOW SPINDLE
- ☐ SPECIALIZED LATHES
- ☐ CUTTER GRINDERS

THE SPACE BELOW BOUGHT AND PAID FOR BY LeBLOND FOR YOUR EXCLUSIVE USE





Dept. I-14



Add to the HEALTHFULNESS *and* APPEAL

OF RAILWAY TRAVEL

...with ULTRA-VIOLET RAYS and *VITALIZED AIR CONDITIONING*

EVERY RAILROAD is up against the problem of cutting expenses. An opportunity to reduce costs and secure greater health and comfort for railway travel is worth investigating. And here it is... VITALIZED AIR CONDITIONING, with ultra-violet sterilization.

In a few words, Sturtevant *Vitalized* Air Conditioning is the automatic and economical treatment of air, to render it more livable, more like the air of the woodland and the sea—and Ultra-Violet Rays contribute to this result.

For cars equipped with mechanical refrigeration, *Vitalized* Air Conditioning means that 100% outdoor air can be circulated under automatic wet bulb temperature control—without overloading the existing compressor-condenser system. It also means lower maintenance, through less frequent starting and stopping of the compressor.

For cars equipped with ice cooling systems, it means satisfactory regulation of evaporative cooling—with resulting savings in ice consumption.

For *every* conditioned car regardless of cooling system, Vitalized Air Conditioning means:

1. ***Safer air***—treated by the action of the water sprays or ultra-violet rays.
2. ***Vitalized air***—"revigorated" to give it that pleasing, mellow quality associated with outdoor air.
3. ***Cleansed air***—washed and filtered to remove dirt, dust and odors.

We invite you to investigate Vitalized Air Conditioning.

Sturtevant RAIL VANE UNITS OR SYSTEMS

Sturtevant "Railvane" Units or Systems are used by 37 railroads. "Railvane" Air Conditioning is protected by 30 issued patents and other patents pending.

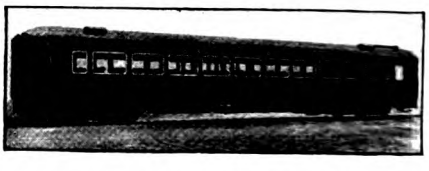


BANGOR & AROOSTOOK COACH INTERIOR

The Sturtevant Ultra-Violet Sterilizer is located directly over the recirculated air grille, to be operated in winter when the sprays are not in service. With this equipment, the benefits of ultra-violet treatment of air have been demonstrated in railway cars after a year of actual operation.

Regular equipment may be provided which will produce no perceptible quantity of ozone.

But when the presence of the small quantities of ozone found in mountain air is desired, special ultra-violet lights may be provided in combinations to meet any desired standards.



B. F. STURTEVANT COMPANY
HYDE PARK, BOSTON, MASS., *Branches in 40 Cities*
B. F. Sturtevant Company of Canada, Ltd.
Galt, Toronto, Montreal

FOR 28 YEARS... PIONEERS IN AIR CONDITIONING

TIMKEN Bearings Lengthen Driving Wheel Tire Life

REDUCE TIRE TURNING

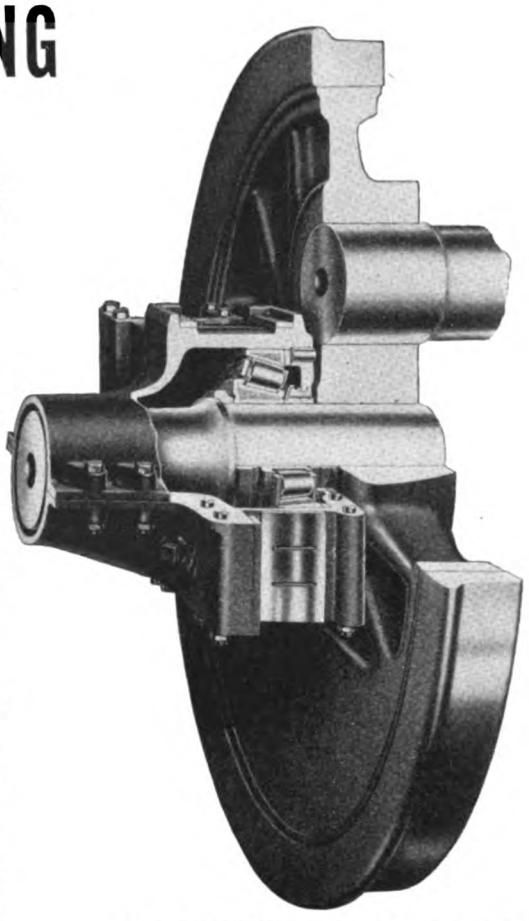
It has now been definitely proved that locomotive driving wheel tires last considerably longer when the driving axles are mounted on TIMKEN Bearings. The intervals between tire turnings are also greatly increased.

This is due to the fact that Timken Bearing Equipped driving axles are perfectly aligned and squared with the locomotive frame and with each other, enabling close operating clearances to be constantly maintained. As a further result, greatly increased smoothness of locomotive operation is also secured, because the wheels are kept round due to the effect of true revolving action.

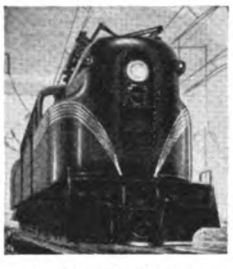
A Timken Bearing Equipped locomotive is given a permanent "operating lateral" when it is built. No breaking-in is required. On the other hand in a friction bearing locomotive the lateral between the boxes and hub liners is set up very close to begin with so as to allow for wear during the running-in period. However, by the time the locomotive "frees itself" the driving box lateral is usually too great and must be closed up again.

Railroads operating Timken Bearing Equipped locomotives have found that they can run these engines from 100,000 to 125,000 miles before dropping the wheels to turn the tires. This compares with from 35,000 to 75,000 miles in the case of friction bearing locomotives of the same type. One railroad has advised that they expect to get 200,000 miles before dropping the wheels to turn the tires!

Furthermore, the perfect wheel and axle alignment and free lateral conditions of Timken Bearing Equipped locomotives are reflected in the longer life of driving rods, motion work and other moving parts of the locomotive.



A typical TIMKEN Railway Bearing driving axle application for steam locomotives.

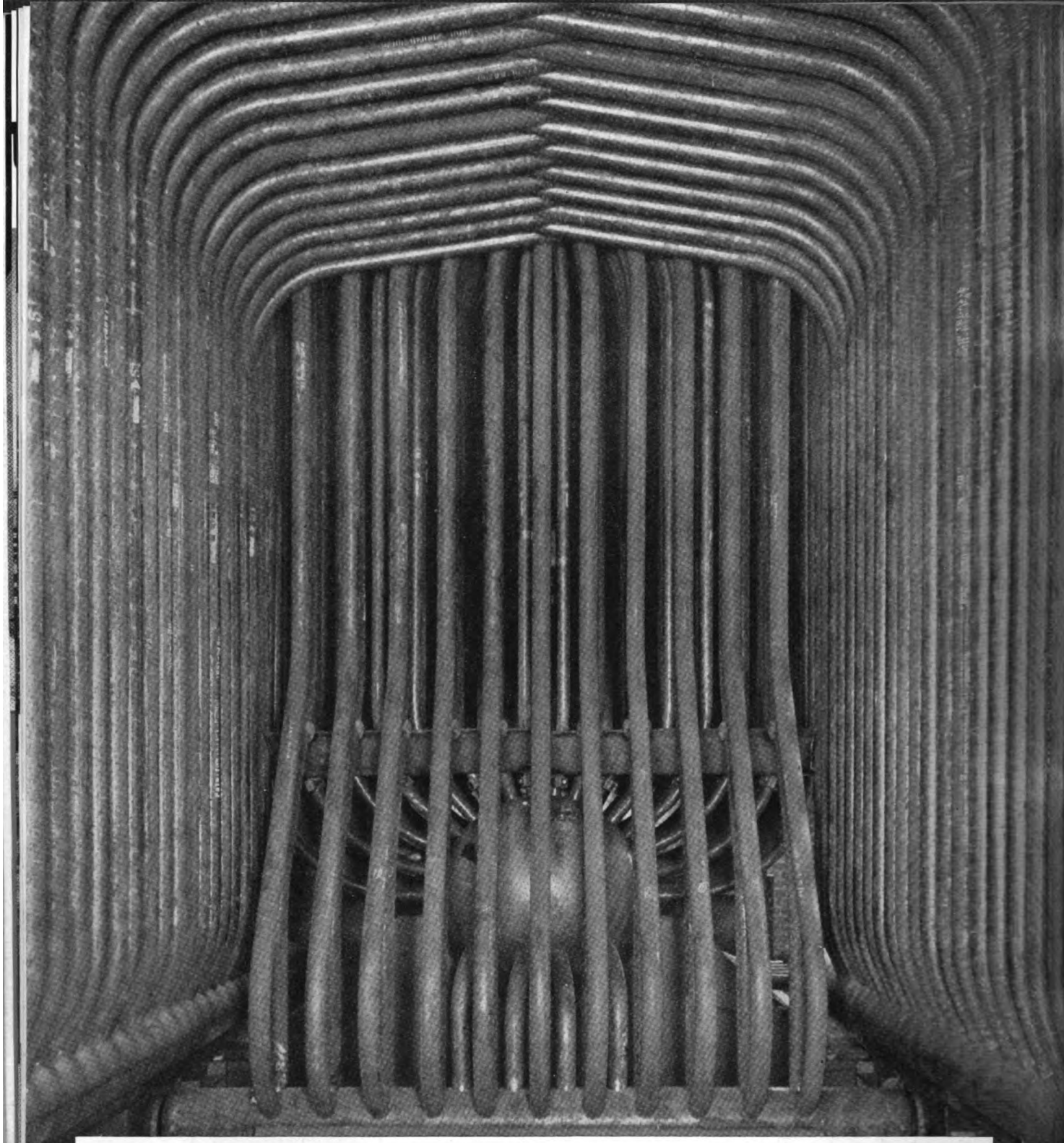


The Pennsylvania's new Broadway Limited rolls on TIMKEN Bearings.
GLIDE—as you ride a Timken Bearing Equipped train

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Manufacturers of TIMKEN Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; TIMKEN Alloy Steels and Carbon and Alloy Seamless Tubing; TIMKEN Rock Bits; and TIMKEN Fuel Injection Equipment.

TIMKEN
RAILWAY ROLLER BEARINGS



Here's Your Opportunity to Learn All About —

ELECTRUNITE

REG. U.S. PAT. OFF.

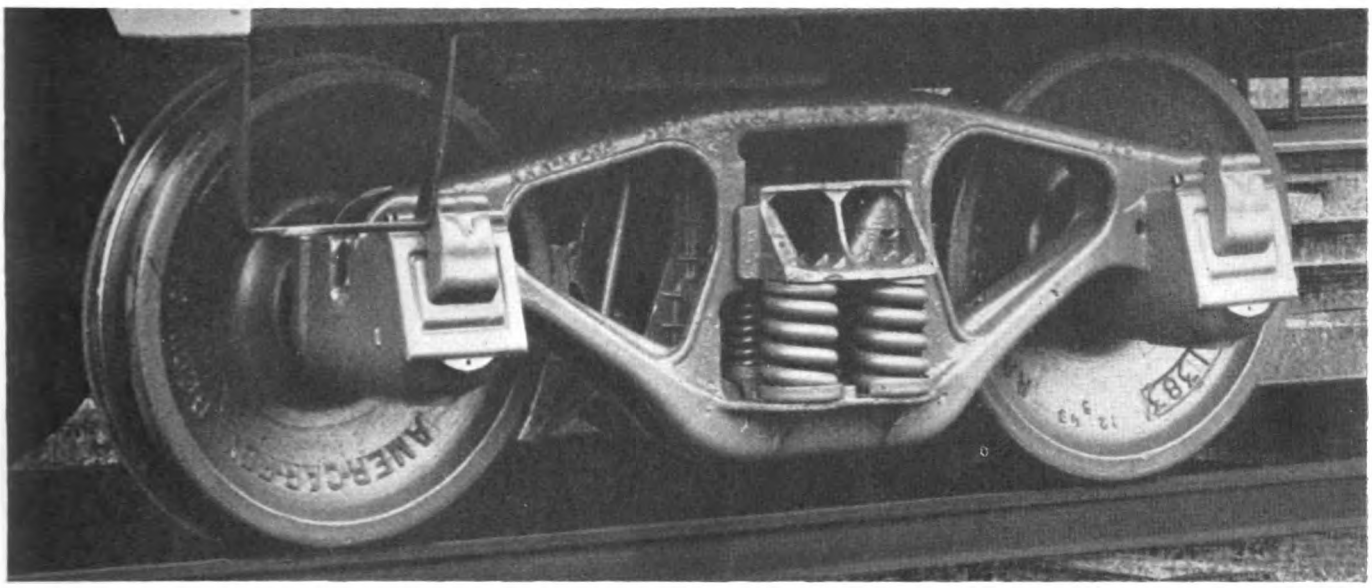
STEEL AND TUBES ELECTRIC WELD

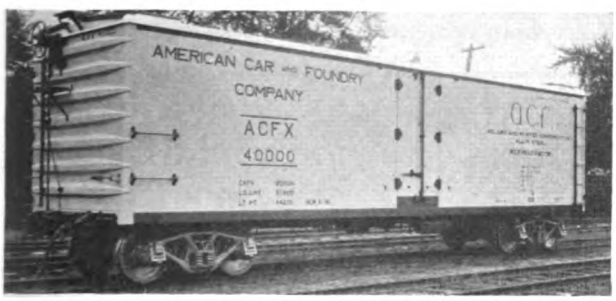
BOILER TUBES

If you attend the Power Show, be sure to visit the ELECTRUNITE exhibit at Booth 10. There you will have an opportunity to learn all about the many features of this modern boiler tube and why each year more users are turning to ELECTRUNITE. • Should you not be able to visit the show, your nearest ELECTRUNITE distributor will gladly give you this information. See him or write us. Steel and Tubes, Inc., Cleveland, Ohio. (Subsidiary of Republic Steel Corp.)

YOU'LL FIND ELECTRUNITE AT BOOTH 10 AT THE POWER SHOW, GRAND CENTRAL PALACE, NEW YORK CITY, DECEMBER 5th TO 10th

BARBER
STABILIZED TRUCKS *Selected*





Upper illustration shows the Barber Stabilized Truck, Type S-2, used under the new American Car and Foundry exhibit refrigerator car. Barber trucks can be used with or without spring planks. Designs available for all capacities and also for 4-wheel tender trucks.

BARBER
Stabilized
Trucks
Save You More
for More Years

. . . *for Latest*
Light Weight, Welded, All Steel
REFRIGERATOR CAR

built by American Car and Foundry for exhibit purposes.

The BARBER truck is built on sound engineering ideas. It is *initially tight* and STAYS tight. Rugged, large-area friction members act against wear plates on columns, eliminating all *looseness and wear* between bolsters and columns.

Any slight wear that may develop in friction members from years of service is automatically taken up.

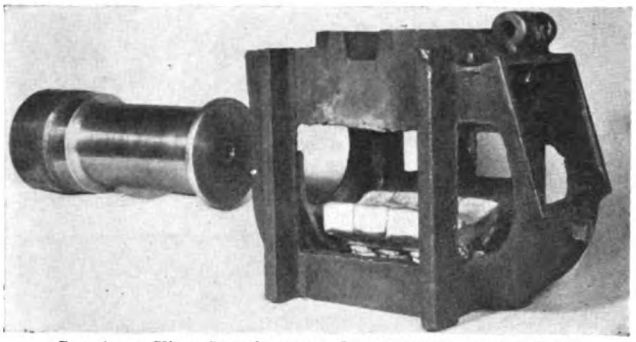
Bouncing action is positively controlled, smooth riding assured, lading damage claims reduced and spring breakage eliminated.

Purdue tests show that frictional resistance between wear plate and friction block is correctly proportioned according to load in car body.

The BARBER Stabilized Truck is the TRUCK TO USE for the solution to numerous problems in the maintenance and operation of freight equipment.

STANDARD CAR TRUCK COMPANY
332 SOUTH MICHIGAN AVENUE CHICAGO, ILLINOIS

THIS WINTER - Save Time at YOUR Wheel Pit . . . Use the *Improved* FELPAX LUBRICATOR



Cut-Away View Showing how Journal Box may be Easily Removed and Re-applied when Changing Wheels, without Disturbing the Improved Felpax Lubricator.

To gain first-hand knowledge of *non-glazing* FELPAX LUBRICATORS, we suggest you place a trial order. The initial cost is low. Our service engineer will help acquaint your men with them. TEST this lubricator in ACTUAL SERVICE on your own line. If it does not do *all that we claim*, return it AT OUR EXPENSE.

It will PAY YOU to discover the savings FELPAX LUBRICATORS can effect on YOUR ROAD *this winter*. Write us.

IN USE ON 15 AMERICAN, CANADIAN AND BRITISH R.R. SYSTEMS.

For additional FELPAX features, please refer to page 27, November issue of Railway Mechanical Engineer.

1. Remove journal box in usual manner, leaving *entire* lubricator *intact* in box . . . no inconvenience or loss of time.

CHANGE WHEELS, and

2. Replace journal box on axle as usual, with lubricator *still intact . . . the box is already packed.*

The box is removed and replaced as if no packing were in it . . . no wrenches or special tools needed for entire operation.

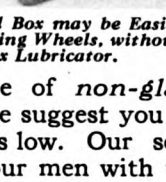
The *improved* FELPAX eliminates: Removal of waste packing from box . . . Thawing out frozen boxes . . . Repacking box . . . Renovating removed packing.

On YOUR ROAD, through *coldest winter* or *hottest summer* these lubricators on passenger cars and tenders would *not require* removal between normal wheel changes.

MILLER FELPAX COMPANY

WINONA MINNESOTA

This new blade-type RIDGID cutter wheel assures you quick, clean low cost pipe cutting





Like the blade of a good knife, this RIDGID cutter wheel blade is made of fine tool steel — for more cutting power and stamina. It's coined, hammered, heat-treated and cast into a solid hub. Many more cuts per wheel, practically no burr . . . And thousands of users will tell you that this steel reinforced cutter always cuts true, twirls easily to size. For speedier better work and less cutter wheel expense, buy the RIDGID — at your Supply House.

THE RIDGE TOOL CO., ELYRIA, O.

RIDGID PIPE TOOLS

GET TOGETHER DEPARTMENT

POSITIONS OPEN POSITIONS WANTED

WANTED

TRUCK SIDE FRAMES, Freight Car
From dismantled cars or surplus stocks

IRON & STEEL PRODUCTS, INC.
Chicago (Hegewisch Sta.), Ill.
Buyers Sellers Traders
"Anything containing IRON or STEEL"

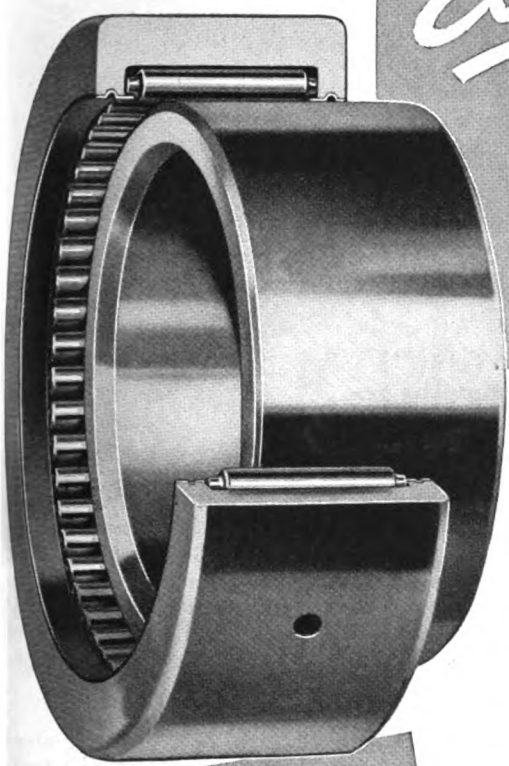
Classified Advertisements—Help and Situation Wanted advertisements appearing in the "Get Together Department," 10c a word an insertion. Minimum charge $2.00 for each insertion. For Sale Advertisements $10.00 a column inch. Any number of inches may be used. Copy must be in this office by the 10th of each month preceding to insure insertion in the issue.

New Type — BANTAM QUILL BEARING!

Excels WHERE LOADS ARE HEAVIEST

WHERE RELIABILITY IS PARAMOUNT

WHERE LOWER COSTS ARE ESSENTIAL



WIDE RANGE OF SIZES CARRIED IN STOCK!

HERE'S the answer to your need for a bearing which takes less space, has high load capacity, yet sells at a low price. Bantam Standard Series Quill Bearings are the result of years of pioneering in the production of Quill and Needle Bearings and offer many advantages. Design has been greatly simplified. No fragile parts, thereby avoiding possibility of failure. End Thrust is taken on ribs of the one-piece channel-shaped outer race.

Bantam Standard Quill Bearings are available for immediate delivery in shaft sizes from ½" to 5".

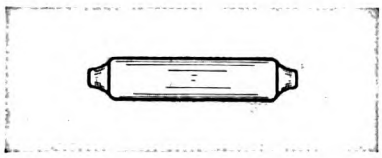
Full Engineering Data on Bantam Standard Series Quill Bearing is available. Send today for Bulletin 103W.

For Needle Bearings to be used in lighter service request Circular 19A from our affiliate, The Torrington Company, Torrington, Conn.

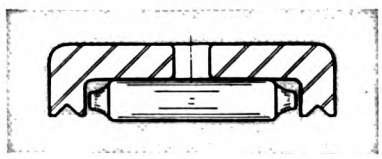
BANTAM BEARINGS CORPORATION
SOUTH BEND, INDIANA
Subsidiary of THE TORRINGTON CO.
Torrington, Conn.

A complete range of sizes for shafts from ½" to 5" diameter is carried in stock ready for immediate shipment. Available with or without inner races.

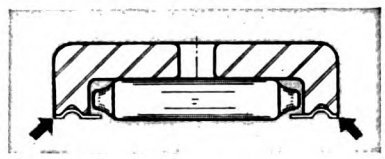
BANTAM BEARINGS



Correctly proportioned rollers with husky curvilinear trunnions eliminating high stresses on trunnions. Accurately hardened and ground for long life.



One-piece channel-shaped outer race. Rigid surfaces all accurately hardened and ground providing solid abutment for end of roller. Assures longer bearing life.

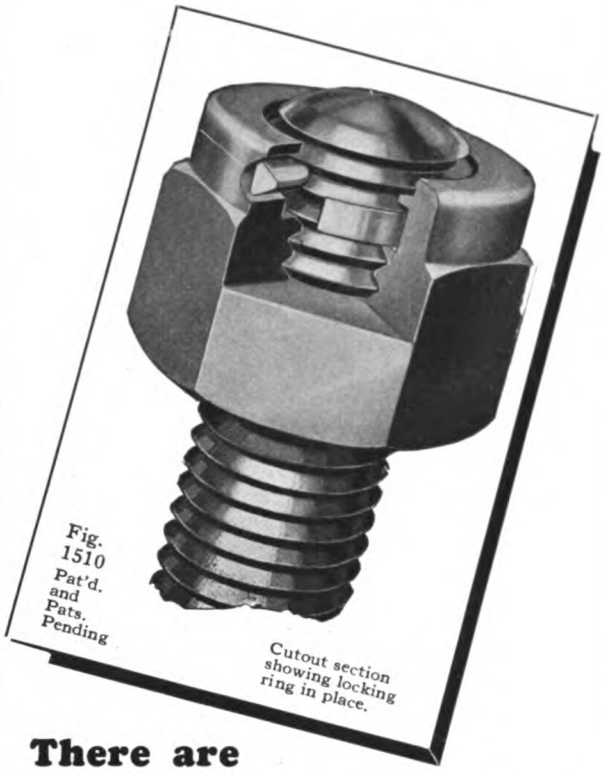


All fragile parts have been eliminated. Simplified method for definite roller retainment. Function of the retaining band is completed when bearing is assembled.

TAPERED ROLLER • • • STRAIGHT ROLLER • • • BALL BEARINGS

UNSHAKO

The Nut That Can't Shake Loose



There are many places on Cars and Locomotives where this NUT can be used to lower maintenance costs.

WE can show you a long list of such spots where "Unshako" can be used advantageously. The fact that the use of these nuts will keep your equipment in better condition for longer periods is readily understandable when you see the tenacity with which they cling to a bolt or stud in spite of the most severe shaking and jarring. Their built-in locking ring will not let them loosen in the slightest. This one-piece construction of "Unshako" saves you money on installation time, as there is no wasted time required for applying locking washers or pins. Just slip on the "Unshako" as you would a regular hex-head nut, tighten it up and forget it. It's there to stay and can only come off when a wrench is applied. However, then it's no trouble.

Write us. We'll tell you all about the "Unshako" Self-Locker, where you can use it and how it can save you many headaches.

STANDARD PRESSED STEEL CO.

BRANCHES BOSTON DETROIT INDIANAPOLIS — JENKINTOWN, PENNA. Box 573 — BRANCHES CHICAGO ST. LOUIS SAN FRANCISCO

THESE WRENCH TESTS ASTOUNDED OUR ENGINEERS!



● So surprising were the strengths revealed in careful tests of Williams' "Superior" Wrenches, that our engineers at first questioned their own findings. Such performance, as indicated by these tests, had never been associated previously with Carbon Steel wrenches. But developments in metallurgy, coupled with advances in manufacturing methods, have enabled Williams' engineers to produce an Improved Carbon Steel Wrench approximately *twice as strong* as old-fashioned wrenches of this type.

Drop-forged from improved quality carbon steel and specially processed to Williams' exacting specifications, "Superior" Wrenches average *93% as strong as Alloy Steel Wrenches of similar size.* They are actually stronger than the Double Head Engineers' Pattern alloy wrenches of usual thin design. They cost considerably less! They provide a better hand grip than the usual thin alloy wrench . . . they insure greater and safer bearing on the nut. Make your next wrenches Williams' "Superiors"...50 patterns, over 1000 standard sizes.

Stronger ***ADJUSTABLE WRENCHES*** *also!*



From similar specially-processed Carbon Steel—this improved Adjustable Wrench is positively the strongest carbon steel wrench of its type made—averages 80% as strong as the strongest corresponding alloy wrench. It, likewise, costs much less. Five sizes—4 to 12". Sizes 15 and 18" of another make, equal to other commercial brands, can also be supplied.

J. H. WILLIAMS & CO.

86 Spring Street, New York

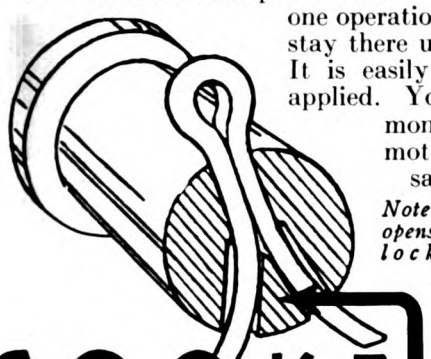
Headquarters for: Drop-Forged Wrenches (Carbon and Alloy), Detachable Socket Wrenches, Reversible Ratchet Wrenches, Tool Holders, "C" Clamps, Lathe Dogs, Eye Bolts, Hoist Hooks, Thumb Nuts and Screws, Chain Pipe Tongs, Vises, etc.

Greater SAFETY For a Lower Cost

WHY take chances with ordinary cotters—especially since the speeds of all trains have been increased?

Every application on a car, locomotive or any other moving vehicle can be made in absolute safety with the COOKE Pin and Cotter.

A couple of taps with a hammer drives the COOKE Cotter into place. It is securely locked in one operation—and it will stay there until removed. It is easily and quickly applied. You save time, money and promote maximum safety.



Note: This wedge opens, spreads and locks the cotter, thereby eliminating vibration and wear.

COOKE PIN and COTTER

"SELF OPENING—SELF LOCKING"

American Railway Products Co.
162 Post Road, Darien, Conn.

KING SANDER TRAP Nº 34

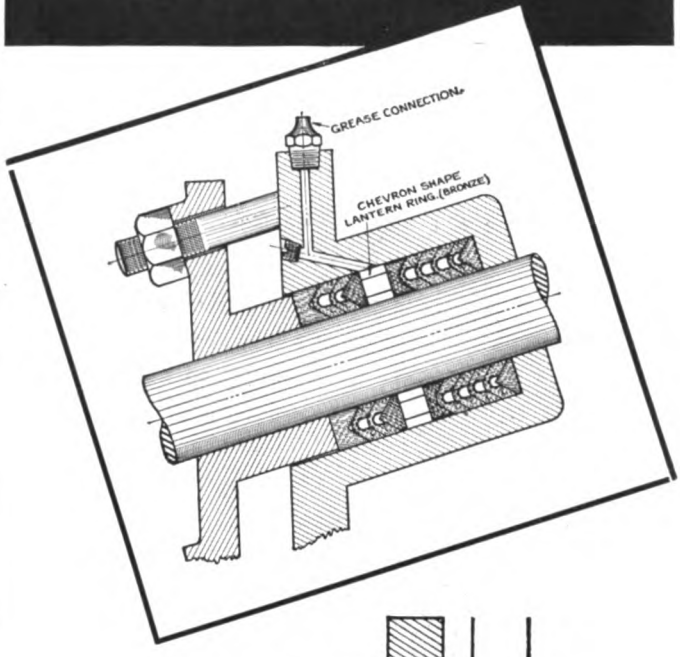


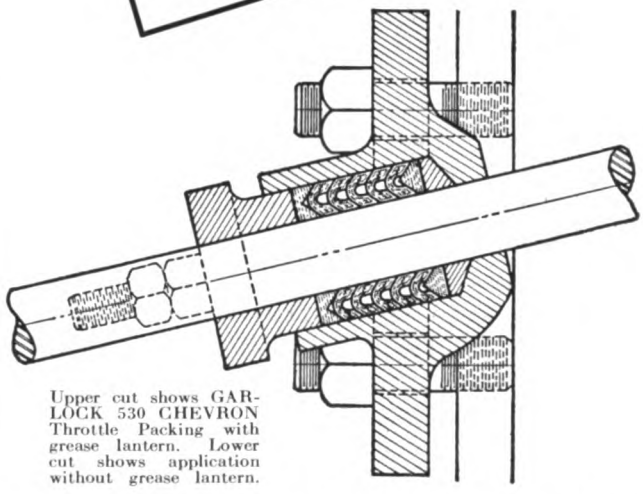
Provision for automatic cleaning blast embodied within the trap. Adjustable for grade of sand, flow required and air pressure.

Single, Duplex and Triplex operating valves to suit varying arrangements.

THE U. S. METALLIC PACKING CO.
PHILADELPHIA, PENNSYLVANIA

CHEVRON
Throttle Packing





Upper cut shows GARLOCK 530 CHEVRON Throttle Packing with grease lantern. Lower cut shows application without grease lantern.

GARLOCK 530 CHEVRON Throttle Packing is made of special asbestos cloth and Garlock rubber friction, molded under heavy pressure into the unique and exclusive CHEVRON shape. Because of its outstanding service and economy it has been adopted as standard throttle packing on many railroads. It is a real money saver. Let us tell you more about it.



THE GARLOCK PACKING CO.
PALMYRA, NEW YORK

In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

GARLOCK

THE EDITOR'S DESK

MERRY CHRISTMAS AND A HAPPY NEW YEAR

It is physically impossible to express our holiday greetings to most of you in person, and so we take this opportunity of wishing each and every one of our good friends among the Readers and Advertisers a Merry Christmas and a Happy and Prosperous New Year.

The experts who diagnose car loadings and business trends tell us that, relatively, there has been a steady improvement during recent months. There seems to be almost a unanimity of belief that home building in the United States will be greatly stimulated in 1939. This, in itself, will mean much to the railroads and transportation agencies.

Not all the economists agree in their predictions, but marked improvement in other lines of industry and commerce is predicted by many of them. This should have a good effect upon railroad earnings. For the mechanical department, in particular, it means that shops and repair plants will become more active and that many furloughed employees will be called back into service. Experience over the years indicates that the railroads will spend at least as much in purchases of equipment, facilities and materials as they earn in net income—possibly more if business prospects continue to be favorable and money for rehabilitation can be secured at low interest rates.

Regardless of what one may think of the wage settlement, there seems to be little question but what the labor leaders and employees recognize that an unusual degree of co-operation will be required of them if the railroads are to continue as a private enterprise—and judging from the expressions and attitude of some of the labor leaders, we can expect close and cordial co-operation from the workers in helping to restore prosperity to the railroads.

The leaders of the Administration and the public, quite generally, have indicated that there must be remedial legislation which will remove unfair handicaps from the railroads and make it possible for them to get back on a sound, prosperous basis. It is true that some of the legislators and regulators in a self-righteous way persist in the attitude that railroad managements are solely at fault and that they must be soundly spanked before relief will be granted. Public opinion, however, is becoming exceedingly critical of the leaders who have stood in the way of granting relief to the railroads and let us hope that the public will have its way and that we will see real, constructive leadership on the part of the Administration and Congress, which will give the railroads a square deal, and that is all that they want. Surely this is not expecting too much!

Our wish for a prosperous New Year, therefore, is not just an idle sentiment, but seems to have a sound and realistic basis.

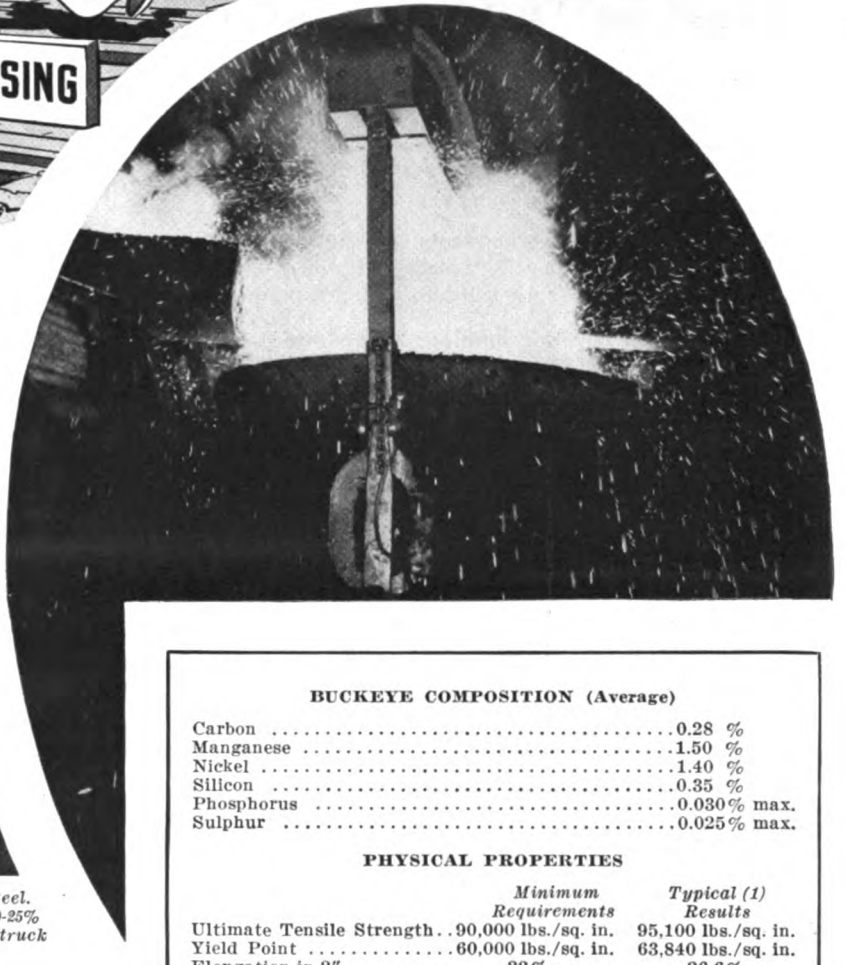
Sincerely,

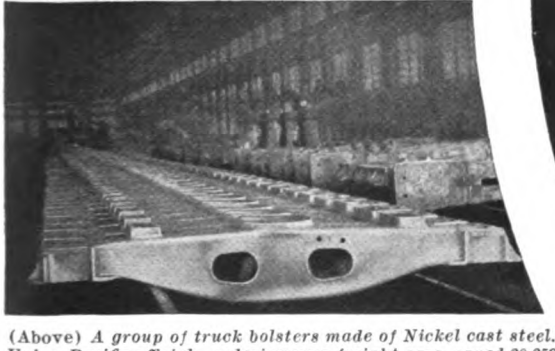
Roy V. Wright

Chase those DEADHEAD TONS *with* CAST NICKEL STEELS



You chase free riders from your freights but are you stopping the most *flagrant* operating loss — the wasted cost of hauling millions of tons of useless deadweight in old type equipment? You can stop that needless loss by using modern Nickel cast steels for important rolling stock castings.





(Above) *A group of truck bolsters made of Nickel cast steel. Union Pacific officials, ordering new freight cars, saved 20-25% under casting weights by specifying Nickel cast steels in truck bolsters made by Buckeye Steel Castings Company.*

BUCKEYE COMPOSITION (Average)

Carbon	0.28 %
Manganese	1.50 %
Nickel	1.40 %
Silicon	0.35 %
Phosphorus	0.030% max.
Sulphur	0.025% max.

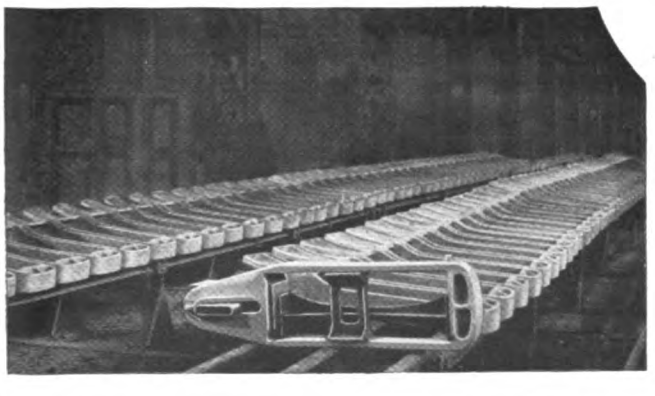
PHYSICAL PROPERTIES

	Minimum Requirements	*Typical (1) Results*
Ultimate Tensile Strength	90,000 lbs./sq. in.	95,100 lbs./sq. in.
Yield Point	60,000 lbs./sq. in.	63,840 lbs./sq. in.
Elongation in 2"	22%	26.6%
Reduction of Area	45%	57.9%

STATIC TEST RESULTS

Bolsters:	Minimum allowable breaking load	423,500 lbs.
	Actual breaking load	509,200 lbs.
Yokes:	Minimum allowable breaking load	550,000 lbs.
	Actual breaking load	655,300 lbs.

(1) Heat Treatment: Normalize at 1600° F., air cooled and subsequent tempering at 1100° F. Typical results taken on test bars attached to castings.



(Left) *5,200 light weight cast steel draft yokes were recently completed for the Union Pacific by Buckeye Steel Castings Company. This Columbus, Ohio, railroad foundry pioneered development of high-strength Nickel alloy cast steels. Nickel adds toughness, assures uniformity.*

THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK, N.Y.

One OF THESE IS Hard Boiled



The hardboiled egg, although it looks just like the other, has been given something "extra." So, too, Ex-Cell-O railroad pins, or bushings, may appear the same as others, but they have been ground after hardening to give them extra life.

Here is how Ex-Cell-O pins and bushings are made to stand up longer, why their long life reduces other maintenance expenses, and what their use has done for certain railroads:

How Ex-Cell-O Pins and Bushings Are Made

Ex-Cell-O pins and bushings are made of S. A. E. No. 1010 steel, in the standard sizes listed in our catalog. After machining, they are carburized, and allowed to cool; this refines the cores, and makes them ductile to withstand shocks in service. Then the pins and bushings are re-heated, and quenched in oil and brine; this produces a uniform surface hardness, from $\frac{1}{32}$" to $\frac{1}{16}$" deep, that withstands service wear. They now have a hardness of 60 Rockwell "C" scale, or 610 Brinell, and a minimum tensile strength of 55,000 lbs. per sq. in. that withstands cracking and shearing. The heat treatment used is standard S. A. E. IV.

After hardening, Ex-Cell-O pins and bushings are ground to a smooth finish on all wearing surfaces. A tolerance for size of .002 inch is held in grinding on the outside diameter of the pins, and on the inside diameter of the bushings. The inside and outside diameters of the bushings are ground concentric within .005 inch indicator reading. This precision grinding produces a smooth bearing between pins and bushings. Ex-Cell-O pins and bushings of the same size are interchangeable, and all conform to A. A. R. Specifications.

Wear is Slow and Uniform

Ex-Cell-O pins and bushings are used for locomotive driver brakes, spring rigging and frames, and for passenger car and tender trucks, brake rigging and frames. Wear on Ex-Cell-O pins and bushings occurs slowly—one or two thousandths of an inch wear is noticeable only after two or three hundred thousand miles of service. This wear is evenly distributed, over all wearing surfaces. The reason is that Ex-Cell-O pins and bushings are smooth and uniformly hard.

Dirt, cinders and other abrasive particles from the roadbed do not form heavy deposits which might cause seizing and brake failures; instead, they are pulverized between the bushing and pin, and ejected in the form of dust. The cotter hole in the pin does not become distorted by wear, which might allow the cotter key to work free and thus permit the pin itself to fall out.

Even distribution of wear on the surfaces of Ex-Cell-O pins and bushings also maintains the alignment of foundation parts, such as springs, levers, hangers, airbrake parts, brake heads and brake shoes. Brake shoes do not over-ride the wheel rims, and the possibility of thermal check is thus reduced. There is no lost motion in brake applications; therefore fewer emergency applications are necessary.

Because wear on Ex-Cell-O pins and bushings occurs slowly and is uniformly distributed, their condition and probable remaining life are accurately determined on scheduled inspections. This eliminates failures in service—failures that would interrupt train schedules while running repairs were made, or would cause rough riding and cocking. Cocking would in turn accelerate wear, and even necessitate replacement of expensive foundation parts.

What Railroads Have Found

Actual reports, typical of those received from more than 100 railroad customers: (Railroad A) $30,000 annual saving is being made on 515 freight and passenger locomotives equipped with Ex-Cell-O pins and bushings in spring and brake rigging. (Railroad B) This railroad was the first one to make a trial application of Ex-Cell-O pins and bushings, to a dining car seven years ago. This car has since seen about 700,000 miles of service, but the original Ex-Cell-O pins and bushings have not needed replacement. (Railroad C) Ex-Cell-O pins and bushings have outworn the parts to which they were applied. (Railroad D) All passenger cars equipped with Ex-Cell-O pins and bushings four years ago: no replacements necessary since then. (Railroad E) Saves $5.00 apiece by reclaiming brake beam struts having worn fulcrum holes, with Ex-Cell-O pins and bushings. Detailed information, including the names of these railroads is available.

The experience of more than 100 railroads, both major and short-line, with Ex-Cell-O pins and bushings indicates savings of over $125.00 a year are obtainable on each tender and passenger car. Greater savings are possible on locomotives.

All rolling stock can be equipped from the 148 standard sizes of Ex-Cell-O pins and bushings. They are carried in stock, and can be shipped immediately. Your railroad is thus able to reduce inventories and make a further saving.

You can determine the reduction in maintenance cost on your own equipment by making a trial application of Ex-Cell-O pins and bushings. Check them for size and alignment at every shopping. Then compare their life and cost per mile with that of the pins and bushings you are now using. You will find that a substantial saving can be made by completely equipping your rolling stock with pins and bushings made by the Railroad Division, Ex-Cell-O Corporation, 1226 Oakman Boulevard, Detroit, Mich.

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